Motion Imagery Standards Board
Engineering Guideline

EG 0601

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UAV Datalink Local Metadata Set

1 Scope

This MISB Engineering Guideline (EG) details the Unmanned Air Vehicle (UAV) Datalink Local Data Set (LDS) for UAV platforms. The UAV Datalink LDS is an extensible SMPTE (Society of Motion Picture Television Engineers) Key-Length-Value (KLV) Local Metadata Set designed for transmission through a wireless communications link (Datalink).

This EG provides direction on the creation of a standard Local Data Set for a reliable, bandwidth-efficient exchange of metadata among digital motion imagery systems on UAV platforms. This EG also provides a mapping to Predator Exploitation Support Data (ESD) for continued support of existing metadata systems.

The UAV Local Data Set metadata is intended to be produced locally within a UAV platform and included in an MPEG2 Transport Stream (or equivalent transport mechanism). The MPEG2 Transport Stream (or equivalent) also contains compressed motion imagery from sensors such as an Electro-Optical / Infrared (EO/IR) video capture device. Synchronization between the metadata and the appropriate video packet is also required for ensuring the validity of the metadata. The MPEG2 Transport Stream (or equivalent) embedded with UAV LDS metadata is then transmitted over a medium bandwidth (e.g. 1 to 5Mb/s) wireless Datalink and then disseminated.

The scope of this document is to provide a framework for an extensible bandwidth efficient Local Data Set which enhances sensor captured imagery with relevant metadata. This EG also provides a mapping between UAV Datalink Local Data Set items, ESD items, and Universal Data Set (UDS) items defined in the latest SMPTE KLV dictionary (RP-210).

2 References

2.1 SMPTE 336M-2001, Data Encoding Protocol Using Key-Length-Value

2.2 SMPTE RP210.7-2003, Metadata Dictionary Core Video Metadata Profile, Version 1.0, Video Working Group, 14 March 1997

2.3 MISB RP 0103.1, Timing Reconciliation Metadata Set for Digital Motion Imagery, 11 October 2001

2.4 MISB EG 0104.3, Predator UAV Basic Universal Metadata Set, 15 June 2004

2.5 MISB RP 0107, Bit and Byte Order for Metadata in Motion Imagery Files and Streams, 11 October, 2001

2.6 MIL-STD-2500B V2.1, National Imagery Transmission format Standard, 01 March 2001

2.7 ASI-00209 Rev D, Exploitation Support Data (ESD) External Interface Control Document, 04 December, 2002

2.8 ISO 1000:1992(E), SI units and recommendations for the use of their multiples and of certain other units, 11 January, 1992

2.9 IEEE 1003.1, Information Technology---Portable Operating System Interface (POSIX), 2004

3 Introduction

A SMPTE 336M Universal Data Set (UDS) provides access to a range of KLV formatted metadata items. Transmitting the 16-byte key, basic encoding rules (BER) formatted length, and data value is appropriate for applications where bandwidth isn't a concern. However, transmitting the 16-byte universal key quickly uses up the available bandwidth in bandwidth-challenged environments.

The Motion Imagery Standards Board (MISB) Engineering Guideline MISB EG 0104.3 entitled "Predator UAV Basic Universal Metadata Set" shows a translation between basic ESD and Universal Data Set (UDS) metadata items that exist in the most current version of the SMPTE KLV dictionary. The UDS items in the MISB EG 0104.3 document are more appropriate for higher bandwidth interfaces (e.g. > 10Mb/s) like for dissemination, whereas this document targets low to medium bandwidth interfaces (e.g. 1 to 5Mb/s).

UAV platforms typically use a wireless communications channel that allots a limited amount of bandwidth for metadata. Because of the bandwidth disadvantages of using a Universal Data Set, it is more desirable to use a Local Data Set for transmission over a UAV Datalink. As discussed in SMPTE 336M, a Local Data Set can use a 1, 2 or 4-byte key with a 1, 2, 4-byte, or BER encoded length. This UAV Local Data Set uses a 1-byte key and BER encoded length to minimize bandwidth requirements while still allowing the LDS ample room for growth (up to 255 metadata items).

This EG identifies a way to encode metadata locally in the airborne platform into a standard KLV Local Data Set. This standardized method is intended to be extensible to include future relevant metadata with mappings between new LDS, UDS, and ESD metadata items (where appropriate). When a new metadata LDS item is added or required, action must be taken to add an equivalent (i.e. identical in data format) Universal Data Set metadata item to the proper metadata dictionary (public or private) if the UDS metadata item does not already exist.

This method also provides a mapping between Local Data Set items and currently implemented Universal Data Set items defined in the SMPTE KLV dictionary (RP-210).

3.1 Local Data Set Changes and Updates

This document defines the UAV Datalink Local Metadata Set and is under configuration management. Any changes to this document must be accompanied by a document revision and date change and coordinated with the managing organization.

Software applications that implement this interface should allow for metadata items in the UAV Local Data Set that are unknown so that they are forward compatible with future versions of the interface.

NOTE: Universal Keys which correspond exactly in data content to the Local Data Set metadata items defined here have not been secured at initial release. These "UDS Mirror" metadata keys are represented with "TBD" in the LDS metadata table in section 5.

4 UAV Datalink Local Data Set

This section defines the UAV Datalink Local Data Set (LDS). The keys that are supported in this LDS are defined and mapped to metadata items in the SMPTE KLV Dictionary (RP-210) as well as the Exploitation Support Data (ESD) specification where appropriate. The UAV Datalink Local Metadata Set is SMPTE 336M KLV compliant.

The following section defines the metadata items contained in the LDS.

The subsections that follow discuss the topics listed below:

- 4.1: LDS Packet Structure
- 4.2: Data Collection and Dissemination
- 4.3: Timestamping
- 4.4: Error Detection

The 16-byte Universal Key for this UAV Local Data Set is to be defined by the MISB. A key history is provided below as a way to track the keys used in engineering and development.

Key: `06 0E 2B 34 - 01 01 01 01 - 0F 00 00 00 - 00 00 00 00`

Date Released: November 2005

Description: Experimental node key used in software development efforts at General Atomics prior to the assignment of a defined key.

Key: `06 0E 2B 34 - 02 03 01 01 - 01 79 01 01 - 01 xx xx xx`

Date Released: October 25, 2005

Description: This key was released as a placeholder within this document. Much development has been based around draft versions of this document which has used this key in some software implementations.

4.1 LDS Packet Structure

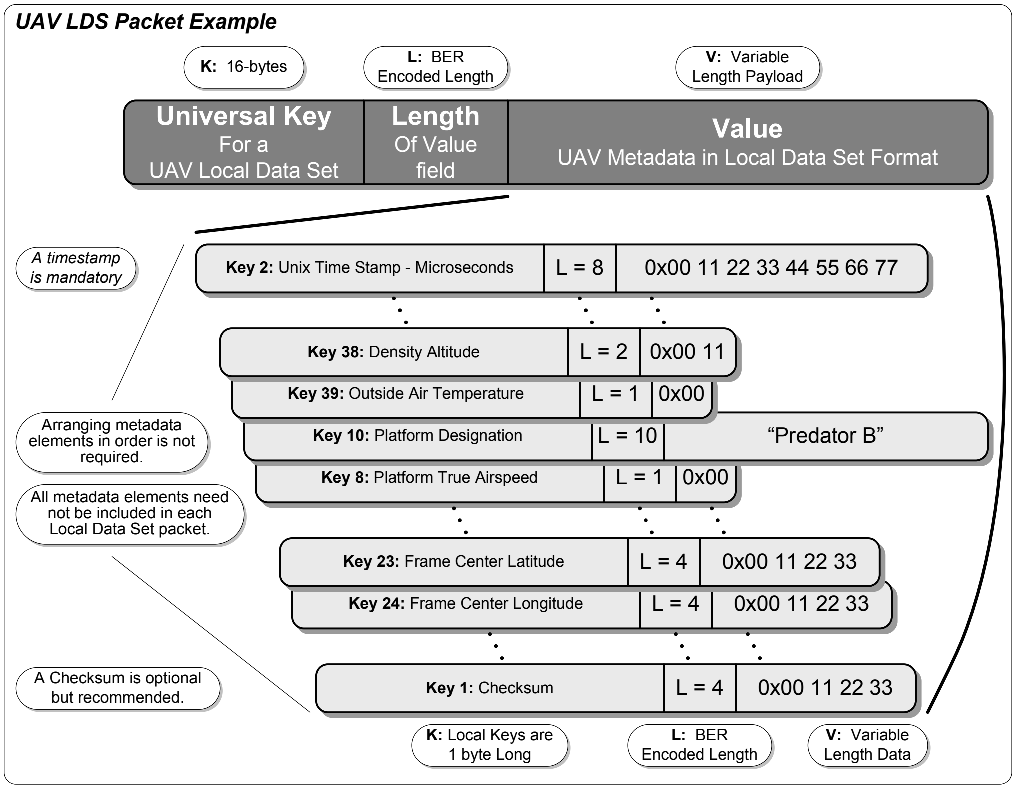

Figure 4-1: Example of a UAV Local Data Set Packet

Figure 4-1 shows the general format of how the LDS is configured. It is required that each LDS packet contain a Unix-based timestamp that represents the time of birth of the metadata within the LDS packet. Time stamping of metadata is discussed in section 4.2. A checksum metadata item is also strongly recommended to be included in each LDS packet. Checksums are discussed in section 4.3.

Any combination of metadata items can be included in a UAV Local Data Set packet. Also, to be SMPTE 336M compliant, the items within the UAV LDS can be arranged in any order. However, in practice the timestamp is often positioned at the beginning of an LDS packet. Similarly, the checksum often appears as the last metadata item due to algorithms surrounding its computation and creation.

4.1.1 Bit and Byte ordering

All metadata is represented using big-endian (Most Significant Byte (MSB) first) encoding. Bytes are big-endian bit encoding (most significant bit (msb) first).

4.1.2 Length Field Encoding

The length field is encoded using basic encoding rules (BER) for either short or long form encoding of octets. This length encoding method provides the greatest level of flexibility for variable length data contained within a KLV packet.

In practice, the majority of metadata items in a LDS packet will use the short form of length encoding which requires only a single byte to represent the length. The length of the entire LDS packet, however, is often represented using the long form of length encoding since the majority of packets have a payload larger than 127 bytes. The length of a single packet is represented by 2 bytes whenever the payload portion of the LDS packet is less than 256 bytes. Both short and long form encoding is discussed in the subsections that follow.

See SMPTE 336M section 3.2 for further details.

4.1.2.1 BER Short Form Length Encoding

For UAV LDS packets and data elements shorter than 128 bytes, the length field is encoded using the BER short form. Length fields using the short form are represented using a single byte (8 bits). The most significant bit in this byte signals that the long form is being used. The last seven bits depict the number of bytes that follow the BER encoded length. An example LDS packet using a short form encoded length is shown below:

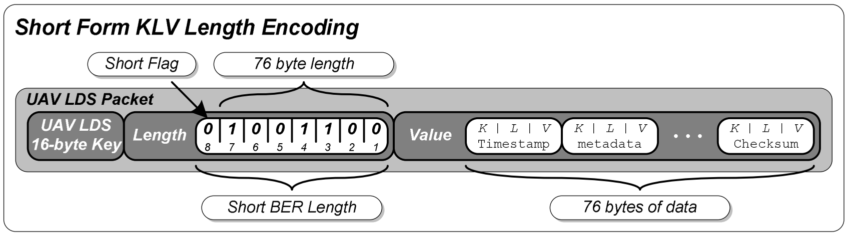

Figure 4-2: Example Short Form Length Encoding

4.1.2.2 BER Long form length encoding

For LDS packets and data elements longer than 127 bytes, the length field is encoded using the BER long form. The long form encodes length fields using multiple bytes. The first byte indicates long form encoding as well as the number of subsequent bytes that represent the length. The bytes that follow the leading byte are the encoding of an unsigned binary integer which is equal to the number of bytes in the payload portion of the packet. An example LDS packet using a long form encoded length is shown below:

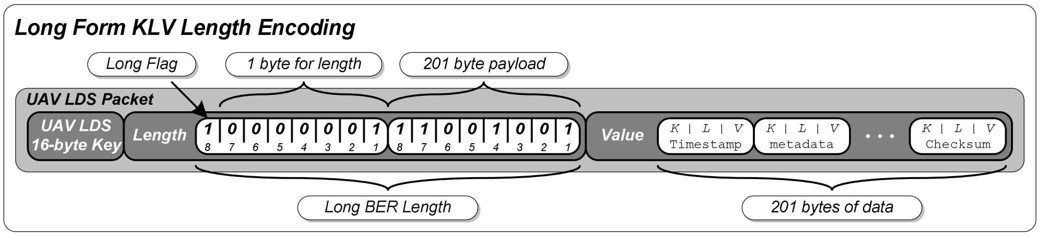

Figure 4-3: Example Long Form Length Encoding

4.2 Data Collection and Dissemination

Within the air vehicle, metadata is collected, processed, and then distributed by the flight computer (or equivalent) through the most appropriate interface (RS-422, 1553, Ethernet, Firewire, etc.). See the figure below:

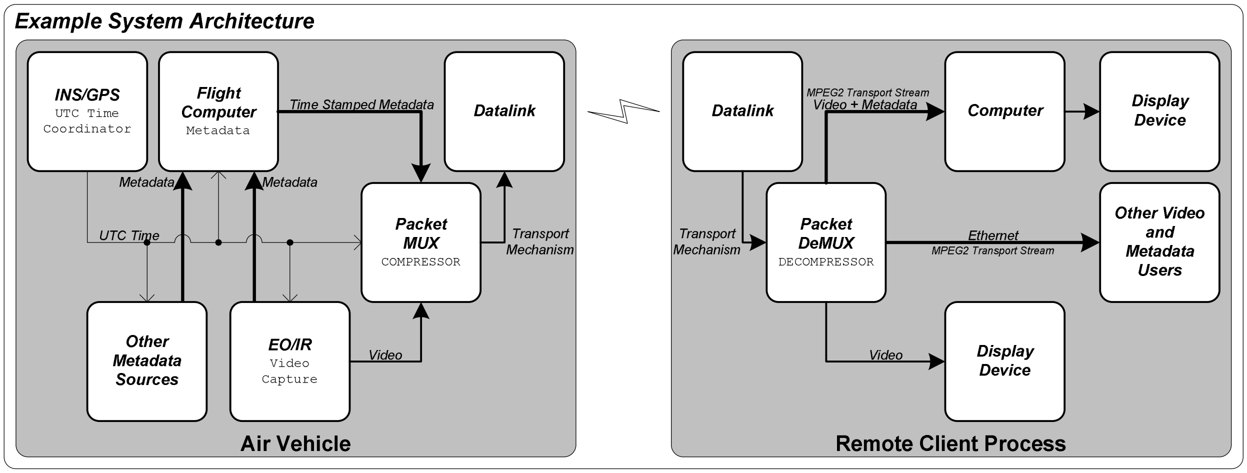

Figure 4-4: System Architecture

Sensors and other metadata sources pass metadata to the flight computer.

The flight computer (or equivalent) places a timestamp in the UAV LDS packet prior to passing it to the Video Encoder / Packet Multiplexer. See section 4.3 for more information about using timestamps in the LDS metadata packet.

The flight computer merges all appropriate metadata items and a timestamp into a LDS packet and transmits it with a checksum to the video encoder Packet Multiplexer. The encoder adds the metadata to a transport stream mechanism which is passed through a communications link to a remote client process that can decode and process the video and metadata contained within the transport stream. The remote client process can then display and/or distribute the video and metadata as appropriate.

4.3 Time Stamping

Every LDS KLV packet is required to include a Unix-based timestamp as a way to correspond the metadata with a standardized time reference. Unix-time is useful to associate metadata with frames, and for reviewing time-critical events at a later date. This section describes how to include a timestamp within a UAV Local Data Set packet.

Metadata sources and the flight computer (or equivalent) are coordinated to operate on the same coordinated time which is GPS derived. A source of metadata, or the flight computer, provides a timestamp for inclusion in a LDS packet. The timestamp assists the accuracy of synchronizing each frame to its corresponding metadata set.

The mandatory timestamp is named “Unix Timestamp”. The timestamp (key 2) is an 8 byte unsigned integer that represents the number of microseconds that have elapsed since midnight (00:00:00), January 1, 1970. This date is known as the Unix epoch and is discussed in the IEEE POSIX standard IEEE 1003.1.

4.3.1 Packet Timestamp

An LDS Packet Timestamp is inserted at the beginning of the value portion of a UAV LDS packet. One LDS metadata item is required to represent Unix Time and is recommended to be inserted just after the BER encoded length field of the LDS packet, although this positioning is not manditory.

The timestamp represented by Key 2 (Unix Timestamp) applies to all metadata in the LDS packet. This timestamp corresponds to the time of birth of all the data within the LDS packet. This time can be used to associate the metadata with a particular video frame and be displayed or monitored appropriately.

An example LDS packet containing a timestamp is show below:

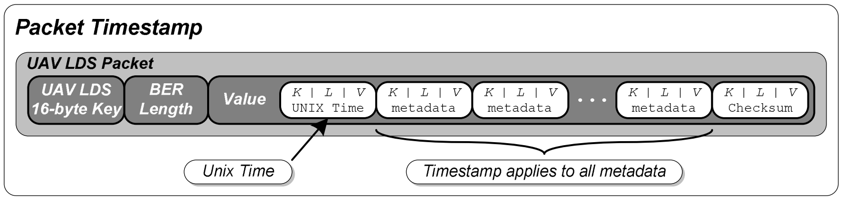

Figure 4-5: Packet Timestamp Example

4.4 Error Detection

To help prevent erroneous metadata from being presented with video, it is highly recommended that a 16-bit checksum is included in every UAV Local Data Set packet. The checksum can be located anywhere within the packet and is recommended to be placed at the end due to the processes that compute the checksum. The checksum is a running 16-byte sum through the entire LDS packet starting with the 16 byte Local Data Set key and ending with summing the length field of the checksum data item. The figure below shows the data range that the checksum is performed over:

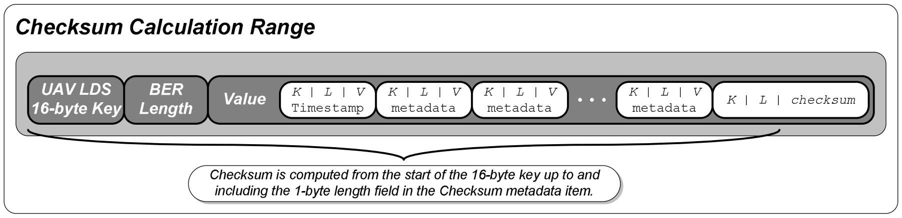

Figure 4-6: Checksum Computation Range

An example algorithm for calculating the checksum is shown below:

```
unsigned short bcc_16 (
  unsigned char * buff,  // Pointer to the first byte in the 16-byte UAV LDS key.
  unsigned short len )   // Length from 16-byte UDS key up to 1-byte checksum length.
{
  // Initialize Checksum and counter variables.
  unsigned short bcc = 0, i;

  // Sum each 16-bit chunk within the buffer into a checksum
  for ( i = 0 ; i < len; i++)
    bcc += buff[i] << (8 * ((i + 1) % 2));
  return bcc;
}  // end of bcc_16 ()
```

If the calculated checksum of the received LDS packet does not match the checksum stored in the packet, the user must discard this packet as being invalid. The lost LDS packet is of little concern since another packet is available within reasonable proximity (in both data and time) to this lost packet.

5 UAV Local Data Set Tables

This section defines the content of the UAV Local Data Set as well as translation between LDS & ESD, and LDS and PUDS data types.

5.1 UAV Local Data Set Items

Each UAV Local Data Set item is assigned an integer value for its key, a descriptive name, and also has fields indicating the units, range, format, and length of the data item. More detailed information about the data item is included in the Notes column.

Notes:

- The columns labeled “Units”, “Range”, “Format”, “LEN” (for length) and “Notes” all apply to the Local Data Set ONLY and not ESD or UDS data types.
- An “x” within a field below indicates that no data is available..
- The “UDS Mirror” column is the Universal Data Set metadata key reserved to represent the length and data format specified by the corresponding LDS metadata item. The key is the only parameter which differs between UDS and LDS item.
- The “UDS Name” column is an existing metadata key which the UAV LDS is mapped to in some applications.

KEY	LDS Name	UDS Mirror	ESD	ESD Name	UDS	UDS Name	Units	Format	Len	Notes
1	Checksum	TBD	x	x	x	x	None	uint16	2	Checksum used to detect errors within a UAV Local Data Set packet. Lower 16-bits of summation. Performed on entire LDS packet, including 16-byte UDS key and 1-byte checksum length.
2	UNIX Time Stamp	TBD	x	x	06 0E 2B 34 01 01 01 04 07 02 01 01 01 05 00 00	User Defined Time Stamp - microseconds since 1970	Microseconds	uint64	8	Microseconds elapsed since midnight (00:00:00), January 1, 1970. Derived from the POSIX IEEE 1003.1 standard. Resolution: 1 microsecond.
3	Mission ID	TBD	Mn	Mission Number	06 0E 2B 34 01 01 01 01 01 05 05 00 00 00 00 00	Episode Number	String	ISO7	V	Descriptive Mission Identifier to distinguish event or sortie. Format of String TBD. Maximum 127 characters.
4	Platform Tail Number	TBD	x	x	x	x	String	ISO7	V	Identifier of platform as posted. e.g.: "AF008", "BP101", etc. Maximum 127 characters.

KEY	LDS Name	UDS Mirror	ESD	ESD Name	UDS	UDS Name	Units	Format	Len	Notes
5	Platform Heading Angle	TBD	Ih	UAV Heading (INS)	06 0E 2B 34 01 01 01 07 07 01 10 01 06 00 00 00	Platform Heading Angle	Degrees	uint16	2	Aircraft heading angle. Relative between fuselage chord line and True North. Map 0..(2^16-1) to 0..360. Resolution: ~5.5 milli degrees.
6	Platform Pitch Angle	TBD	Ip	UAV Pitch (INS)	06 0E 2B 34 01 01 01 07 07 01 10 01 05 00 00 00	Platform Pitch Angle	Degrees	int16	2	Aircraft pitch angle. Relative between fuselage chord line and the horizon. Positive angles above horizon, negative below. Map -(2^15-1)..(2^15-1) to +/-20. Use -(2^15) as "out of range" indicator. -(2^15) = 0x8000. Resolution: ~610 micro degrees.
7	Platform Roll Angle	TBD	Ir	UAV Roll (INS)	06 0E 2B 34 01 01 01 07 07 01 10 01 04 00 00 00	Platform Roll Angle	Degrees	int16	2	Aircraft roll angle. Relative between horizon and wing chord line. Wings level is 0 degrees. Positive angles for elevated left wing. Map (-2^15-1)..(2^15-1) to +/-50. Use -(2^15) as "out of range" indicator. -(2^15) = 0x8000. Res: ~1525 micro deg.
8	Platform True Airspeed	TBD	As	True Airspeed	x	x	Meters / Second	uint8	1	True airspeed (TAS) of platform. Idicated Airspeed adjusted for temperature and altitude. 0..255 meters/sec. 1 m/s = 1.94384449 knots. Resolution: 1 meter/second.
9	Platform Indicated Airspeed	TBD	Ai	Indicated Airspeed	x	x	Meters / Second	uint8	1	Indicated airspeed (IAS) of platform. Derived from Pitot tube and static pressure sensors. 0..255 meters/sec. 1 m/s = 1.94384449 knots. Resolution: 1 meter/second.

KEY	LDS Name	UDS Mirror	ESD	ESD Name	UDS	UDS Name	Units	Format	Len	Notes
10	Platform Designation	TBD	Pc	Project ID Code	06 0E 2B 34 01 01 01 01 01 01 20 01 00 00 00 00	Device Designation	String	ISO7	V	Use "Project Id Code" from EG0104.3. e.g.: 'Predator', 'Predator B', 'Outrider', 'Pioneer', 'IgnatER', 'Warrior', etc. Maximum 127 characters.
11	Image Source Sensor	TBD	Sn	Sensor Name	06 0E 2B 34 01 01 01 01 04 20 01 02 01 01 00 00	Image Source Device	String	ISO7	V	String of image source sensor. e.g.: 'EO Nose', 'EO Zoom (DLTV)', 'EO Spotter', 'IR Mitsubishi PtSi Model 500', 'IR Mitsubishi PtSi Model 600', 'IR InSb Amber Model TBT', 'LYNX SAR Imagery', 'TESAR Imagery', etc. Maximum 127 characters.
12	Image Coordinate System	TBD	Ic	Image Coordinate System	06 0E 2B 34 01 01 01 01 07 01 01 01 00 00 00 00	Image Coordinate System	String	ISO7	V	String of the image coordinate system used. e.g.: 'Geodetic WGS84', 'Geocentric WGS84', 'UTM', 'None', etc. Maximum 127 characters.
13	Sensor Latitude	TBD	Sa	Sensor Latitude	06 0E 2B 34 01 01 01 03 07 01 02 01 02 04 02 00	Device Latitude	Degrees	int32	4	Sensor Latitude. Based on WGS84 ellipsoid. Map -(2^31-1)..(2^31-1) to +/-90. Use -(2^31) as an "error" indicator. -(2^31) = 0x80000000. Resolution: ~42 nano degrees.
14	Sensor Longitude	TBD	So	Sensor Longitude	06 0E 2B 34 01 01 01 03 07 01 02 01 02 06 02 00	Device Longitude	Degrees	int32	4	Sensor Longitude. Based on WGS84 ellipsoid. Map -(2^31-1)..(2^31-1) to +/-180. Use -(2^31) as an "error" indicator. -(2^31) = 0x80000000. Resolution: ~84 nano degrees.
15	Sensor True Altitude	TBD	Sl	Sensor Altitude	06 0E 2B 34 01 01 01 01 07 01 02 01 02 02 00 00	Device Altitude	Meters	uint16	2	Altitude of sensor as measured from Mean Sea Level (MSL). Map 0..(2^16-1) to -900..19000 meters. 1 meter = 3.2808399 feet. Resolution: ~0.3 meters.

KEY	LDS Name	UDS Mirror	ESD	ESD Name	UDS	UDS Name	Units	Format	Len	Notes
16	Sensor Horizontal Field of View	TBD	Fv	Field of View	06 0E 2B 34 01 01 01 02 04 20 02 01 01 08 00 00	Field of View (FOV-Horizontal)	Degrees	uint16	2	Horizontal field of view of selected imaging sensor. Map 0..(2^16-1) to 0..180. Resolution: ~2.7 milli degrees.
17	Sensor Vertical Field of View	TBD	x	x	x	x	Degrees	uint16	2	Vertical field of view of selected imaging sensor. Map 0..(2^16-1) to 0..180. Resolution: ~2.7 milli degrees.
18	Sensor Relative Azimuth Angle	TBD	x	x	x	x	Degrees	uint32	4	Relative rotation angle of sensor to aircraft platform in azimuth. Rotation angle between aircraft fuselage chord and camera pointing direction as seen from above the platform. Map 0..(2^32-1) to 0..360. Resolution: ~84 nano degrees.
19	Sensor Relative Depression Angle	TBD	x	x	x	x	Degrees	int32	4	Relative Depression Angle of sensor to aircraft platform. Level flight with camera pointing forward is zero degrees. Negative angles down. Map -(2^31-1)..(2^31-1) to +/-180. Use -(2^31) as an "error" indicator. -(2^31) = 0x80000000. Res: ~84 ndeg.
20	Sensor Relative Roll Angle	TBD	x	x	x	x	Degrees	uint32	4	Relative roll angle of sensor to aircraft platform. Twisting angle of camera about lens axis. Top of image is zero degrees. Positive angles are clockwise when looking from behind camera. Map 0..(2^32-1) to 0..360. Resolution: ~84 nano degrees.
21	Slant Range	TBD	Sr	Slant Range	06 0E 2B 34 01 01 01 01 07 01 08 01 01 00 00 00	Slant Range	Meters	uint32	4	Slant range in meters. Distance to target. Map 0..(2^32-1) to 0..5000000 meters. 1 nautical mile (knot) = 1852 meters. Resoluiton: ~1.2 milli meters.

KEY	LDS Name	UDS Mirror	ESD	ESD Name	UDS	UDS Name	Units	Format	Len	Notes
22	Target Width	TBD	Tw	Target Width	06 0E 2B 34 01 01 01 01 07 01 09 02 01 00 00 00	Target Width	Meters	uint16	2	Target Width within sensor field of view. Map 0..(2^16-1) to 0..10000 meters. 1 meter = 3.2808399 feet. Resolution: ~.16 meters.
23	Frame Center Latitude	TBD	Ta	Target Latitude	06 0E 2B 34 01 01 01 01 07 01 02 01 03 02 00 00	Frame Center Latitude	Degrees	int32	4	Terrain Latitude of frame center. Based on WGS84 ellipsoid. Map -(2^31-1)..(2^31-1) to +/-90. Use -(2^31) as an "error" indicator. -(2^31) = 0x80000000. Resolution: ~42 nano degrees.
24	Frame Center Longitude	TBD	To	Target Longitude	06 0E 2B 34 01 01 01 01 07 01 02 01 03 04 00 00	Frame Center Longitude	Degrees	int32	4	Terrain Longitude of frame center. Based on WGS84 ellipsoid. Map -(2^31-1)..(2^31-1) to +/-180. Use -(2^31) as an "error" indicator. -(2^31) = 0x80000000. Resolution: ~84 nano degrees.
25	Frame Center Elevation	TBD	x	x	06 0E 2B 34 01 01 01 06 07 01 02 03 10 00 00 00	Frame Center Elevation	Meters	uint16	2	Terrain elevation at frame center. Map 0..(2^16-1) to -900..19000 meters. Resolution: ~0.3 meters.
26	Corner Latitude Point 1	TBD	Rg	SAR Latitude 4	06 0E 2B 34 01 01 01 03 07 01 02 01 03 07 01 00	Corner Latitude Point 1 (Decimal Degrees)	Degrees	int16	4	Frame Latitude, upper left corner. Based on WGS84 ellipsoid. Map -(2^15-1)..(2^15-1) to +/-90. Use -(2^15) as an "error" indicator. -(2^15) = 0x8000. Resolution: ~2.7 milli degrees.

KEY	LDS Name	UDS Mirror	ESD	ESD Name	UDS	UDS Name	Units	Format	Len	Notes
27	Corner Longitude Point 1	TBD	Rh	SAR Longitude 4	06 0E 2B 34 01 01 01 03 07 01 02 01 03 0B 01 00	Corner Longitude Point 1 (Decimal Degrees)	Degrees	int16	4	Frame Longitude, upper left corner. Based on WGS84 ellipsoid. Map -(2^15-1)..(2^15-1) to +/-180. Use -(2^15) as an "error" indicator. -(2^15) = 0x8000. Resolution: ~5.5 milli degrees.
28	Corner Latitude Point 2	TBD	Ra	SAR Latitude 1	06 0E 2B 34 01 01 01 03 07 01 02 01 03 08 01 00	Corner Latitude Point 2 (Decimal Degrees)	Degrees	int16	4	Frame Latitude, upper right corner. Based on WGS84 ellipsoid. Map -(2^15-1)..(2^15-1) to +/-90. Use -(2^15) as an "error" indicator. -(2^15) = 0x8000. Resolution: ~2.7 milli degrees.
29	Corner Longitude Point 2	TBD	Rb	SAR Longitude 1	06 0E 2B 34 01 01 01 03 07 01 02 01 03 0C 01 00	Corner Longitude Point 2 (Decimal Degrees)	Degrees	int16	4	Frame Longitude, upper right corner. Based on WGS84 ellipsoid. Map -(2^15-1)..(2^15-1) to +/-180. Use -(2^15) as an "error" indicator. -(2^15) = 0x8000. Resolution: ~5.5 milli degrees.
30	Corner Latitude Point 3	TBD	Rc	SAR Latitude 2	06 0E 2B 34 01 01 01 03 07 01 02 01 03 09 01 00	Corner Latitude Point 3 (Decimal Degrees)	Degrees	int16	4	Frame Latitude, lower right corner. Based on WGS84 ellipsoid. Map -(2^15-1)..(2^15-1) to +/-90. Use -(2^15) as an "error" indicator. -(2^15) = 0x8000. Resolution: ~2.7 milli degrees.
31	Corner Longitude Point 3	TBD	Rd	SAR Longitude 2	06 0E 2B 34 01 01 01 03 07 01 02 01 03 0D 01 00	Corner Longitude Point 3 (Decimal Degrees)	Degrees	int16	4	Frame Longitude, lower right corner. Based on WGS84 ellipsoid. Map -(2^15-1)..(2^15-1) to +/-180. Use -(2^15) as an "error" indicator. -(2^15) = 0x8000. Resolution: ~5.5 milli degrees.

KEY	LDS Name	UDS Mirror	ESD	ESD Name	UDS	UDS Name	Units	Format	Len	Notes
32	Corner Latitude Point 4	TBD	Re	SAR Latitude 3	06 0E 2B 34 01 01 01 03 07 01 02 01 03 0A 01 00	Corner Latitude Point 4 (Decimal Degrees)	Degrees	int16	4	Frame Latitude, lower left corner. Based on WGS84 ellipsoid. Map -(2^15-1)..(2^15-1) to +/-90. Use -(2^15) as an "error" indicator. -(2^15) = 0x8000. Resolution: ~2.7 milli degrees.
33	Corner Longitude Point 4	TBD	Rf	SAR Longitude 3	06 0E 2B 34 01 01 01 03 07 01 02 01 03 0E 01 00	Corner Longitude Point 4 (Decimal Degrees)	Degrees	int16	4	Frame Longitude, lower left corner. Based on WGS84 ellipsoid. Map -(2^15-1)..(2^15-1) to +/-180. Use -(2^151) as an "error" indicator. -(2^15) = 0x8000. Resolution: ~5.5 milli degrees.
34	Icing Detected	TBD	Id	Icing Detected	Register	x	Icing Code	uint8	1	Flag for icing detected at aircraft location. 0: Detector off 1: No icing Detected 2: Icing Detected
35	Wind Direction	TBD	Wd	Wind Direction	x	x	Degrees	uint16	2	Wind direction at aircraft location. Map 0..(2^16-1) to 0..360. Resolution: ~5.5 milli degrees.
36	Wind Speed	TBD	Ws	Wind Speed	x	x	Meters / Second	uint8	1	Wind speed at aircraft location. Map 0..255 to 0..100 meters/second. 1 m/s = 1.94384449 knots. Resolution: ~0.4 meters / second.
37	Static Pressure	TBD	Ps	Static Pressure	x	x	Millibar	uint16	2	Static pressure at aircraft location. Map 0..(2^16-1) to 0..5000 mbar. 1 mbar = 0.0145037738 PSI. Resolution: ~0.08 Millibar

KEY	LDS Name	UDS Mirror	ESD	ESD Name	UDS	UDS Name	Units	Format	Len	Notes
38	Density Altitude	TBD	Da	Density Altitude	x	x	Meters	uint16	2	Density altitude at aircraft location. Relative aircraft performance metric based on outside air temperature, static pressure, and humidity. Map 0..(2^16-1) to -900..19000 meters. Offset = -900. 1 meter = 3.2808399 feet. Resolution: ~0.3 meters.
39	Outside Air Temperature	TBD	At	Air Temperature	x	x	Celcius	int8	1	Temperature outside of aircraft. -128..127 Degrees Celcius. Resolution: 1 degree celcius.

Table 1: Predator UAV Datalink Local Metadata Set data elements

5.2 Sensor Image Geoposition Corner Metadata

The Sensor Image Corner Latitude/Longitude metadata consists of the items shown in Figure 10. Corner coordinates are numbered to conform to National Imagery Transmission Format (NITF) Standard numbering convention for single image frame corner coordinates:

Figure 4-7 shows a detailed mapping between metadata items for each corner point.

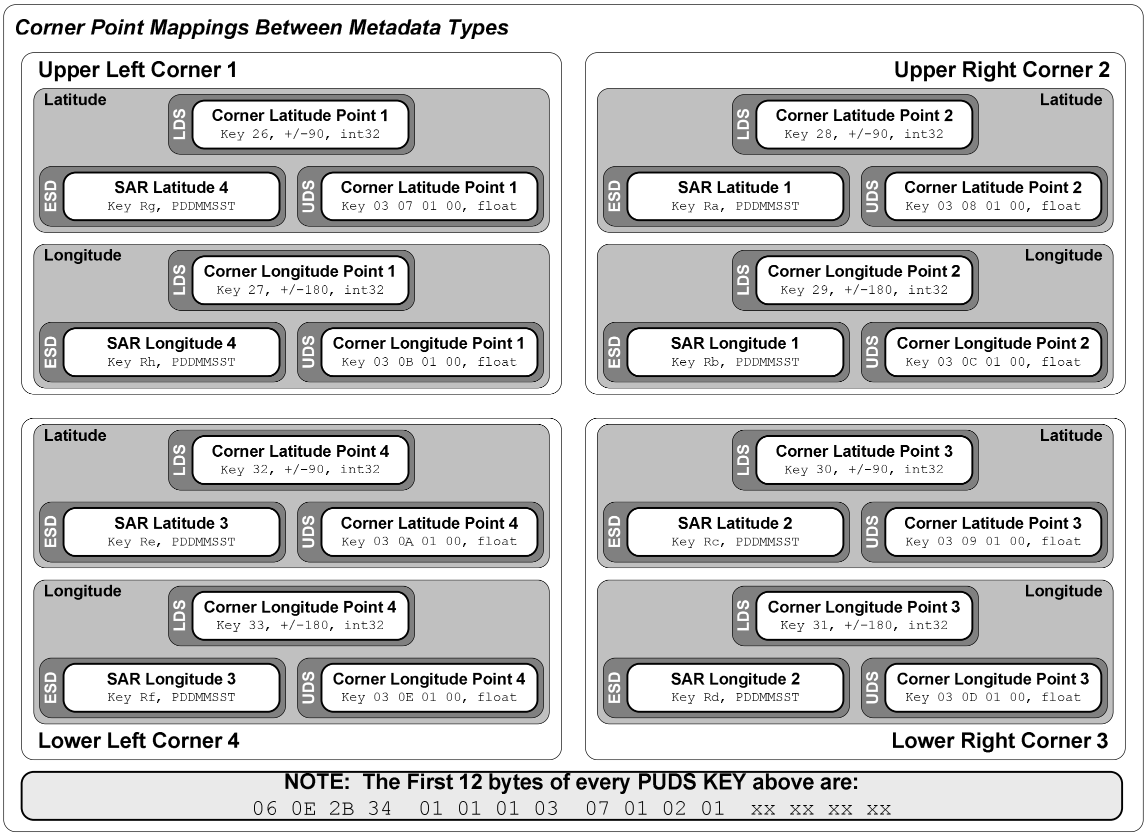

Figure 5-1: Corner Point Mapping

See the NITF Standards document MIL-STD-2500B Version 2.1 for more information about corner coordinates. Corners not corresponding to geographic locations, i.e., above the horizon, are not to be included. This numbering scheme is different than the one used in the ESD interface described in ASI-00209 Rev D "Exploitation Support Data (ESD) External Interface Control Document**"**.

Each LDS Corner Point item assigned here maps to one UDS Corner Point entry in the SMPTE RP210 dictionary. The LDS corner points use a 4-byte signed integer mapped between +/-90 for Latitude entries, and +/-180 for Longitude entries whereas each Latitude and Longitude UDS corner point has one 8-byte floating point value that corresponds to decimal degrees.

6 Conversions and Mappings Between Metadata Types

Metadata items that are common amongst PLDS, UDS, and ESD data formats each convey identical information. However, since each metadata format represents the same metadata items differently (e.g. mapped integer, float, string, etc.), the data resolution between format types is different. This section provides conversions and mappings between PLDS, UDS, and ESD metadata items.

6.1 Key 1: Checksum Conversion

LDS	1		LDS Name	Checksum	
UDS Mirror of LDS Item			Units	Range	Format
TBD			None	0..(2^16-1)	uint16
Notes					
- Checksum used to detect errors within a UAV Local Data Set packet. - Lower 16-bits of summation. - Performed on entire LDS packet, including 16-byte UDS key and 1-byte checksum length.				x	
UDS	x		ESD	x	
UDS Name	x		ESD Name	x	
Units	Range	Format	Units	Range	Format
x	x	x	x	x	x
Notes			Notes		
- x			- x		
UDS Conversion			ESD Cnversion		
x *To UDS:* - x *To LDS:* - x			x *To ESD:* - x *To LDS:* - x		

6.1.1 Example 16-bit Checksum Code

```
unsigned short bcc_16 (
  unsigned char * buff,  // Pointer to the first byte in the 16-byte PLDS key.
  unsigned short len )   // Length from 16-byte UDS key up to 1-byte checksum length.
{
  unsigned short bcc = 0, i;  // Initialize Checksum and counter variables.
  for ( i = 0 ; i < len; i++)
    bcc += buff[i] << (8 * ((i + 1) % 2));
  return bcc;
}  // end of bcc_16 ()
```

6.1.2 Sample Checksum Data

```
64 bits to checksum: 060E 2B34 0200 81BB

          060E
        + 2B34
          3142
        + 0200
          3442
        + 81BB
          B4FD <-- Final Checksum
```

6.2 Key 2: UNIX Time Stamp Conversion

LDS	2	**LDS Name**	UNIX Time Stamp

UDS Mirror of LDS Item	Units	Range	Format
TBD	Microseconds	0..(2^64-1)	uint64

Notes
- Microseconds elapsed since midnight (00:00:00), January 1, 1970. - Derived from the POSIX IEEE 1003.1 standard. - Resolution: 1 microsecond.

UDS	06 0E 2B 34 01 01 01 04 07 02 01 01 01 05 00 00	**ESD**	x
UDS Name	User Defined Time Stamp - microseconds since 1970	**ESD Name**	x

Units	Range	Format	Units	Range	Format
uSec	uint64	uint64	x	x	x

Notes	Notes
- Time Stamp application defined by user. - 64 bit integer which represents the number of microseconds since Jan 1, 1970 UTC derived from the POSIX (IEEE 1003.1) standard.	- x

UDS Conversion	ESD Cnversion
x *To UDS:* - UDS = LDS *To LDS:* - LDS = UDS	x *To ESD:* - x *To LDS:* - x

6.2.1 UNIX Time Stamp

Unix time, or POSIX time, is a system use to discretely label a scale of time. This system is widely used within systems of differing underlying architectures. Unix time is an encoding of Coordinated Universal Time (UTC) and therefore accounts for the addition (or subtraction) of leap seconds. Leap seconds are used to synchronize the UTC clock metric with the yearly rotation period of the earth about the sun.

6.3 Key 3: Mission ID Conversion

LDS	3	LDS Name	Mission ID
UDS Mirror of LDS Item	Units	Range	Format
TBD	String	1..127	ISO7
Notes			
- Descriptive Mission Identifier to distinguish event or sortie. - Format of String TBD. - Maximum 127 characters.	x		

UDS	06 0E 2B 34 01 01 01 01 01 05 05 00 00 00 00 00		ESD	Mn	
UDS Name	Episode Number		ESD Name	Mission Number	
Units	Range	Format	Units	Range	Format
Number	x	Float	Number	x	x
Notes			Notes		
- x			- Number to distinguish different missions started on a given day.		
UDS Conversion			ESD Cnversion		
x			x		
To UDS: - TBD *To LDS:* - TBD			*To ESD:* - TBD *To LDS:* - TBD		

6.3.1 Example Mission ID

TBD

6.4 Key 4: Platform Tail Number Conversion

LDS	4		LDS Name	Platform Tail Number	
UDS Mirror of LDS Item			Units	Range	Format
TBD			String	1..127	ISO7
Notes					
- Identifier of platform as posted. - e.g.: "AF008", "BP101", etc. - Maximum 127 characters.				x	
UDS	x		ESD	x	
UDS Name	x		ESD Name	x	
Units	Range	Format	Units	Range	Format
x	x	x	x	x	x
Notes			Notes		
- x			- x		
UDS Conversion			ESD Cnversion		
x *To UDS:* - x *To LDS:* - x			x *To ESD:* - x *To LDS:* - x		

6.4.1 Example Platform Tail Number

TBD

6.5 Key 5: Platform Heading Angle Conversion

LDS	5		LDS Name	Platform Heading Angle	
UDS Mirror of LDS Item			Units	Range	Format
TBD			Degrees	0..360	uint16
Notes					
- Aircraft heading angle. Relative between fuselage chord line and True North. - Map 0..(2^16-1) to 0..360. - Resolution: ~5.5 milli degrees.			$LDS\_dec = \left(\frac{LDS\_range}{uint\_range} * LDS\_uint\right)$		
UDS	06 0E 2B 34 01 01 01 07 07 01 10 01 06 00 00 00		ESD	Ih	
UDS Name	Platform Heading Angle		ESD Name	UAV Heading (INS)	
Units	Range	Format	Units	Range	Format
Degrees	0..360	Float	Degrees	0..359.99	DDD.HH
Notes			Notes		
- Heading angle of platform expressed in degrees. - The Heading of an airborne platform is the angle from True North of its longitudinal axis projected onto the horizontal plane.			- True heading of the aircraft.		
UDS Conversion			ESD Cnversion		
$UDS\_dec = \left(\frac{360}{65535} * LDS\_uint\right)$ *To UDS:* - UDS = (float)(360/0xFFFF * LDS) *To LDS:* - LDS = (uint16)round((0xFFFF/360 * UDS))			$ESD\_dec = \left(\frac{360}{65535} * LDS\_uint\right)$ *To ESD:* - Convert LDS to decimal. - Convert decimal to ASCII. *To LDS:* - Convert ASCII to decimal. - Map decimal to uint16.		

6.5.1 Example Platform Heading Angle

The aircraft heading angle is defined as the direction the aircraft nose is pointing relative to a true north heading. Angles increase in a clockwise direction while looking from above the aircraft. North is 0 degrees, east is 90, south is 180, and west is 270 degrees from true north. Refer to the figure below:

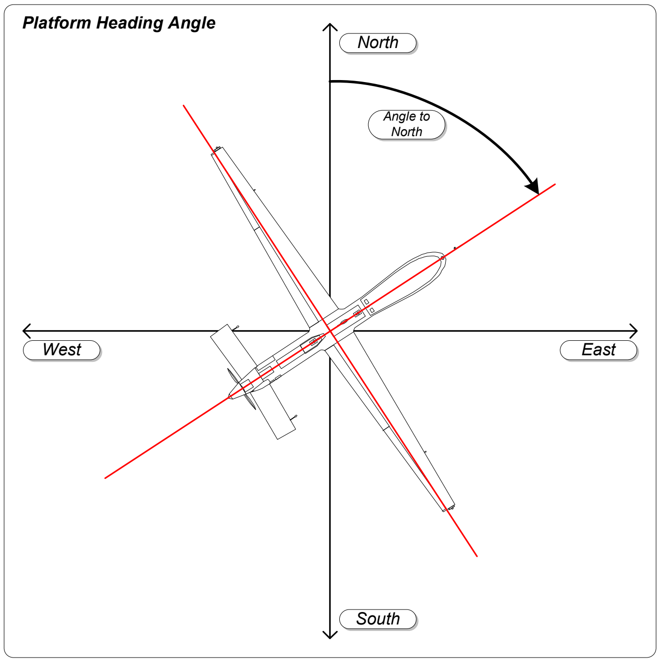

Figure 6-1: Platform True Heading Angle

6.6 Key 6: Platform Pitch Angle Conversion

<table>
<tr><td>LDS</td><td colspan="2">6</td><td>LDS Name</td><td colspan="2">Platform Pitch Angle</td></tr>
<tr><td colspan="3">UDS Mirror of LDS Item</td><td>Units</td><td>Range</td><td>Format</td></tr>
<tr><td colspan="3">TBD</td><td>Degrees</td><td>+/- 20</td><td>int16</td></tr>
<tr><td colspan="6">Notes</td></tr>
<tr><td colspan="3">- Aircraft pitch angle. Relative between fuselage chord line and the horizon.
- Positive angles above horizon, negative below.
- Map -(2^15-1)..(2^15-1) to +/-20.
- Use -(2^15) as "out of range" indicator.
- -(2^15) = 0x8000.
- Resolution: ~610 micro degrees.</td><td colspan="3">$\text{LDS\_dec} = \left(\frac{\text{LDS\_range}}{\text{int\_range}} * \text{LDS\_int}\right)$</td></tr>
<tr><td>UDS</td><td colspan="2">06 0E 2B 34 01 01 01 07
07 01 10 01 05 00 00 00</td><td>ESD</td><td colspan="2">Ip</td></tr>
<tr><td>UDS Name</td><td colspan="2">Platform Pitch Angle</td><td>ESD Name</td><td colspan="2">UAV Pitch (INS)</td></tr>
<tr><td>Units</td><td>Range</td><td>Format</td><td>Units</td><td>Range</td><td>Format</td></tr>
<tr><td>Degrees</td><td>+/- 90</td><td>Float</td><td>Degrees</td><td>+/- 20.0</td><td>PDD.HH</td></tr>
<tr><td colspan="3">Notes</td><td colspan="3">Notes</td></tr>
<tr><td colspan="3">- Pitch angle of platform expressed in degrees.
- The Pitch of an airborne platform describes the angle of its longitudinal (front-to-back) axis makes with the horizontal (i.e., equi-potential gravitational surface);</td><td colspan="3">- Pitch angle of the aircraft.</td></tr>
<tr><td colspan="3">UDS Conversion</td><td colspan="3">ESD Cnversion</td></tr>
<tr><td colspan="3">$\text{UDS\_dec} = \left(\frac{40}{65534} * \text{LDS\_int}\right)$
<u><i>To UDS:</i></u>
- UDS = (float)(40/0xFFFE * LDS)
<u><i>To LDS:</i></u>
- LDS = (int32)round((0xFFFE/40 * UDS))</td><td colspan="3">$\text{ESD\_dec} = \left(\frac{40}{65534} * \text{LDS\_int}\right)$
<u><i>To ESD:</i></u>
- Convert LDS to decimal.
- Convert decimal to ASCII.
<u><i>To LDS:</i></u>
- Convert ASCII to decimal.
- Map decimal to int16.</td></tr>
</table>

6.6.1 Example Platform Pitch Angle

The pitch angle of the aircraft in flight is the angle the fuselage chord makes with the plane of level flight. This plane is parallel to the horizon. Positive angles represent flight operations where the nose of the aircraft is above the horizon line.

Pitch angles are limited to +/- 20 degrees to increase metadata resolution within this range. Should the aircraft experience flight maneuvers beyond this range, an “out of range” indication shall be made within this metadata item. Refer to the figure below:

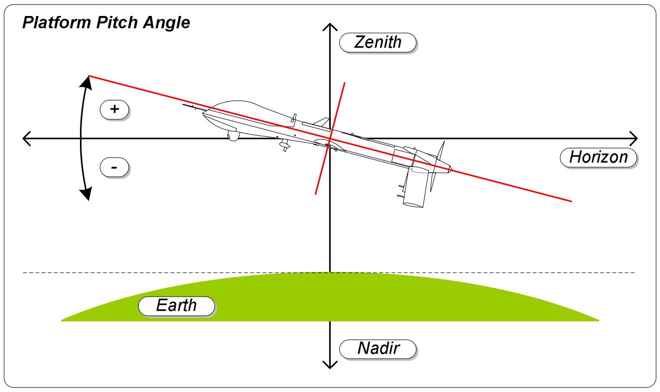

Figure 6-2: Platform Pitch Angle

6.7 Key 7: Platform Roll Angle Conversion

LDS	7	LDS Name	Platform Roll Angle
UDS Mirror of LDS Item	**Units**	**Range**	**Format**
TBD	Degrees	+/- 50	int16

Notes	
- Aircraft roll angle. Relative between horizon and wing chord line. Wings level is 0 degrees. Positive angles for elevated left wing. - Map (-2^15-1)..(2^15-1) to +/-50. - Use -(2^15) as "out of range" indicator. - -(2^15) = 0x8000. - Res: ~1525 micro deg.	$LDS\_dec = \left(\frac{LDS\_range}{int\_range} * LDS\_int\right)$

UDS	06 0E 2B 34 01 01 01 07 07 01 10 01 04 00 00 00	ESD	Ir
UDS Name	Platform Roll Angle	**ESD Name**	UAV Roll (INS)

Units	Range	Format	Units	Range	Format
Degrees	+/- 90	Float	Degrees	+/- 50.0	PDD.HH

Notes	Notes
- Roll angle of platform expressed in degrees. - The Roll of an airborne platform is rotation about its longitudinal (front-to-back) axis; - Wings level is zero degrees, positive (negative) angles describe a platform orientation with the right wing down(up).	- Roll angle of the aircraft.

UDS Conversion	ESD Cnversion
$UDS\_dec = \left(\frac{100}{65534} * LDS\_int\right)$ *To UDS:* - UDS = (float)(100/0xFFFE * LDS) *To LDS:* - LDS = (int32)round((0xFFFE/100 * UDS))	$ESD\_dec = \left(\frac{100}{65534} * LDS\_int\right)$ *To ESD:* - Convert LDS to decimal. - Convert decimal to ASCII. *To LDS:* - Convert ASCII to decimal. - Map decimal to int16.

6.7.1 Example Platform Roll Angle

The roll angle of the aircraft is defined as the angle the wing chord makes relative to the horizontal plane. Positive angles correspond to the left wing being raised above the horizon plane.

Roll angles are limited to +/- 50 degrees to increase metadata resolution within this range. Should the aircraft experience flight maneuvers beyond this range, an "out of range" indication shall be made within this metadata item. Refer to the figure below:

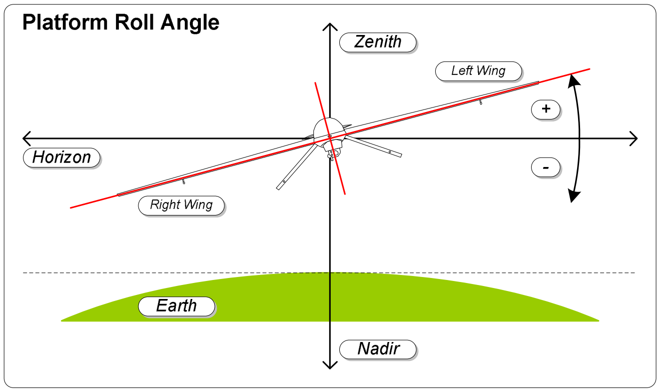

Figure 6-3: Platform Roll Angle

6.8 Key 8: Platform True Airspeed Conversion

<table>
<tr><td>LDS</td><td colspan="2">8</td><td>LDS Name</td><td colspan="2">Platform True Airspeed</td></tr>
<tr><td colspan="3">UDS Mirror of LDS Item</td><td>Units</td><td>Range</td><td>Format</td></tr>
<tr><td colspan="3">TBD</td><td>Meters / Second</td><td>0..255</td><td>uint8</td></tr>
<tr><td colspan="6">Notes</td></tr>
<tr><td colspan="3">- True airspeed (TAS) of platform. Idicated Airspeed adjusted for temperature and altitude.
- 0..255 meters/sec.
- 1 m/s = 1.94384449 knots.
- Resolution: 1 meter/second.</td><td colspan="3">$LDS\_dec = LDS\_int$</td></tr>
<tr><td>UDS</td><td colspan="2">x</td><td>ESD</td><td colspan="2">As</td></tr>
<tr><td>UDS Name</td><td colspan="2">x</td><td>ESD Name</td><td colspan="2">True Airspeed</td></tr>
<tr><td>Units</td><td>Range</td><td>Format</td><td>Units</td><td>Range</td><td>Format</td></tr>
<tr><td>x</td><td>x</td><td>x</td><td>Knots</td><td>0..999</td><td>N</td></tr>
<tr><td colspan="3">Notes</td><td colspan="3">Notes</td></tr>
<tr><td colspan="3">- x</td><td colspan="3">- True airspeed of the aircraft.</td></tr>
<tr><td colspan="3">UDS Conversion</td><td colspan="3">ESD Cnversion</td></tr>
<tr><td colspan="3">x
<i>To UDS:</i>
- x
<i>To LDS:</i>
- x</td><td colspan="3">$ESD\_dec = \left(LDS\_uint * \frac{1.94384449\ knots}{1\ meters/second} \right)$
<i>To ESD:</i>
- Map LDS to integer.
- Convert integer value to ASCII.
<i>To LDS:</i>
- Convert ASCII to integer.
- Map integer to uint8.</td></tr>
</table>

6.8.1 Example Platform True Airspeed

True airspeed is the actual speed an aircraft is traveling relative through the air mass in which it flies. Without a relative wind condition, the true airspeed is equal to the speed over the ground. The true airspeed of the aircraft is calculated using the outside temperature, impact pressure (pitot tube), and static pressure.

6.9 Key 9: Platform Indicated Airspeed Conversion

<table>
<tr><td>LDS</td><td colspan="2">9</td><td>LDS Name</td><td colspan="2">Platform Indicated Airspeed</td></tr>
<tr><td colspan="3">UDS Mirror of LDS Item</td><td>Units</td><td>Range</td><td>Format</td></tr>
<tr><td colspan="3">TBD</td><td>Meters / Second</td><td>0..255</td><td>uint8</td></tr>
<tr><td colspan="6">Notes</td></tr>
<tr><td colspan="3">- Indicated airspeed (IAS) of platform. Derived from Pitot tube and static pressure sensors.
- 0..255 meters/sec.
- 1 m/s = 1.94384449 knots.
- Resolution: 1 meter/second.</td><td colspan="3">LDS_dec = LDS_int</td></tr>
<tr><td>UDS</td><td colspan="2">x</td><td>ESD</td><td colspan="2">Ai</td></tr>
<tr><td>UDS Name</td><td colspan="2">x</td><td>ESD Name</td><td colspan="2">Indicated Airspeed</td></tr>
<tr><td>Units</td><td>Range</td><td>Format</td><td>Units</td><td>Range</td><td>Format</td></tr>
<tr><td>x</td><td>x</td><td>x</td><td>Knots</td><td>0..999</td><td>N</td></tr>
<tr><td colspan="3">Notes</td><td colspan="3">Notes</td></tr>
<tr><td colspan="3">- x</td><td colspan="3">- Indicated airspeed of the aircraft.</td></tr>
<tr><td colspan="3">UDS Conversion</td><td colspan="3">ESD Cnversion</td></tr>
<tr><td colspan="3">x
To UDS:
- x
To LDS:
- x</td><td colspan="3">$ESD\_dec = \left(LDS\_uint * \frac{1.94384449\ knots}{1\ meters/second} \right)$
To ESD:
- Map LDS to integer.
- Convert integer value to ASCII.
To LDS:
- Convert ASCII to integer.
- Map integer to uint8.</td></tr>
</table>

6.9.1 Example Platform Indicated Airspeed

The indicated airspeed of an aircraft is calculated from the difference between static pressure, and impact pressure. Static pressure is measured by a sensor not directly in the air stream and impact pressure is measured by a Pitot tube positioned strategically within the air stream. The difference in pressure while moving provides a way to calculate the indicated platform airspeed.

6.10 Key 10: Platform Designation Conversion

<table>
<tr><td>LDS</td><td colspan="2">10</td><td>LDS Name</td><td colspan="2">Platform Designation</td></tr>
<tr><td colspan="3">UDS Mirror of LDS Item</td><td>Units</td><td>Range</td><td>Format</td></tr>
<tr><td colspan="3">TBD</td><td>String</td><td>0..127</td><td>ISO7</td></tr>
<tr><td colspan="6">Notes</td></tr>
<tr><td colspan="3">- Use "Project Id Code" from EG0104.3.
- e.g.: 'Predator', 'Predator B', 'Outrider', 'Pioneer', 'IgnatER', 'Warrior', etc.
- Maximum 127 characters.</td><td colspan="3">x</td></tr>
<tr><td>UDS</td><td colspan="2">06 0E 2B 34 01 01 01 01
01 01 20 01 00 00 00 00</td><td>ESD</td><td colspan="2">Pc</td></tr>
<tr><td>UDS Name</td><td colspan="2">Device Designation</td><td>ESD Name</td><td colspan="2">Project ID Code</td></tr>
<tr><td>Units</td><td>Range</td><td>Format</td><td>Units</td><td>Range</td><td>Format</td></tr>
<tr><td>String</td><td>1..32</td><td>ISO7</td><td>Number</td><td>0..99</td><td>N</td></tr>
<tr><td colspan="3">Notes</td><td colspan="3">Notes</td></tr>
<tr><td colspan="3">- Identifies the "house name" of the device used in capturing or generating the essence.
- 32 characters maximum.
- ISO7 character set.</td><td colspan="3">- The Project ID of the Collection Platform (e.g., Predator, Outrider, Pioneer, etc.)</td></tr>
<tr><td colspan="3">UDS Conversion</td><td colspan="3">ESD Cnversion</td></tr>
<tr><td colspan="3">x
To UDS:
- No conversion necessary.
To LDS:
- No conversion necessary.</td><td colspan="3">x
To ESD:
- Convert string to ID code.
To LDS:
- Convert ID code to string.</td></tr>
</table>

6.10.1 Example Platform Designation

The platform designation metadata item distinguishes which platform is carrying the motion imagery generating payload equipment. Some current platforms are shown below:

Figure 6-4: Example Platforms

6.11 Key 11: Image Source Sensor Conversion

LDS	11	LDS Name	Image Source Sensor
UDS Mirror of LDS Item	**Units**	**Range**	**Format**
TBD	String	1..127	ISO7
Notes			
- String of image source sensor. - e.g.: 'EO Nose', 'EO Zoom (DLTV)', 'EO Spotter', 'IR Mitsubishi PtSi Model 500', 'IR Mitsubishi PtSi Model 600', 'IR InSb Amber Model TBT', 'LYNX SAR Imagery', 'TESAR Imagery', etc. - Maximum 127 characters.		x	

UDS	06 0E 2B 34 01 01 01 01 04 20 01 02 01 01 00 00		ESD	Sn	
UDS Name	Image Source Device		**ESD Name**	Sensor Name	
Units	**Range**	**Format**	**Units**	**Range**	**Format**
String	1..32	ISO7	Name Code	0..7	N
Notes			**Notes**		
- Indicates the type of the image source. - 32 characters maximum. - ISO7 character set.			- Identifies the source of the video image. - 0: EO Nose - 1: EO Zoom (DLTV) - 2: EO Spotter - 3: IR Mitsubishi PtSi Model 500 - 4: IR Mitsubishi PtSi Model 600 - 5: IR InSb Amber Model TBD - 6: Lynx SAR Imagery - 7: TESAR Imagery		
UDS Conversion			**ESD Cnversion**		
x *To UDS:* - No conversion necessary. *To LDS:* - No conversion necessary.			x *To ESD:* - Convert string to ID code. *To LDS:* - Convert ID code to string.		

6.11.1 Example Image Source Sensor

A sample imaging source sensor is shown in the figure below:

Figure 6-5: Sample Imaging Sensor

6.12 Key 12: Image Coordinate System Conversion

LDS	12	LDS Name	Image Coordinate System
UDS Mirror of LDS Item	Units	Range	Format
TBD	String	1..127	ISO7
Notes			
- String of the image coordinate system used. - e.g.: 'Geodetic WGS84', 'Geocentric WGS84', 'UTM', 'None', etc. - Maximum 127 characters.	x		

UDS	06 0E 2B 34 01 01 01 01 07 01 01 01 00 00 00 00		ESD	Ic	
UDS Name	Image Coordinate System		ESD Name	Image Coordinate System	
Units	Range	Format	Units	Range	Format
String	1..4	ISO7	Code	0..3	N
Notes			Notes		
- Identifies the Digital Geographic Information Exchange Standard (DIGEST) geo-referenced coordinate system used at image capture. - **** 4 characters maximum. **** - ISO7 character set.			- Identifies the image coordinate system used. - 0: Geodetic WGS84 - 1: Geocentric WGS 84 - 2: UTM - 3: None		
UDS Conversion			ESD Cnversion		
x *To UDS:* - No conversion necessary. *To LDS:* - No conversion necessary.			x *To ESD:* - Convert string to ID code. *To LDS:* - Convert ID code to string.		

6.12.1 World Geodetic System – 1984 (WGS 84)

The World Geodetic System of 1984 (WGS 84) is a 3-D, Earth-centered reference system developed originally by the U.S. Defense Mapping Agency. This system is the official GPS reference system.

6.12.2 Universal Transverse Mercator (UTM)

UTM is the projection of the earth onto a cylinder. The Mercator projection is a conformal projection, meaning that angles and small shapes on the globe project as the same angles on the map. This causes the scale between the center and outer-most portions of the conformal projection to vary greatly.

Applications exist which convert between UTM and WGS84 coordinate systems and their different datum references.

6.13 Key 13: Sensor Latitude Conversion

<table>
<tr><td>LDS</td><td colspan="2">13</td><td>LDS Name</td><td colspan="2">Sensor Latitude</td></tr>
<tr><td colspan="3">UDS Mirror of LDS Item</td><td>Units</td><td>Range</td><td>Format</td></tr>
<tr><td colspan="3">TBD</td><td>Degrees</td><td>+/- 90</td><td>int32</td></tr>
<tr><td colspan="6">Notes</td></tr>
<tr><td colspan="4">- Sensor Latitude. Based on WGS84 ellipsoid.
- Map -(2^31-1)..(2^31-1) to +/-90.
- Use -(2^31) as an "error" indicator.
- -(2^31) = 0x80000000.
- Resolution: ~42 nano degrees.</td><td colspan="2">$\text{LDS\_dec} = \left(\frac{\text{LDS\_range}}{\text{int\_range}} * \text{LDS\_int}\right)$</td></tr>
<tr><td>UDS</td><td colspan="2">06 0E 2B 34 01 01 01 03
07 01 02 01 02 04 02 00</td><td>ESD</td><td colspan="2">Sa</td></tr>
<tr><td>UDS Name</td><td colspan="2">Device Latitude</td><td>ESD Name</td><td colspan="2">Sensor Latitude</td></tr>
<tr><td>Units</td><td>Range</td><td>Format</td><td>Units</td><td>Range</td><td>Format</td></tr>
<tr><td>Degrees</td><td>+/- 90</td><td>Double</td><td>Degrees</td><td>+/- 90.0</td><td>PDDMMSST</td></tr>
<tr><td colspan="3">Notes</td><td colspan="3">Notes</td></tr>
<tr><td colspan="3">- Specifies a sensor's geographic location in decimal degrees of latitude.
- Positive values indicate northern hemisphere.
- Negative values indicate southern hemisphere.</td><td colspan="3">- Latitude of the aircraft. + Means North Latitude. All Latitude coordinates use WGS84.</td></tr>
<tr><td colspan="3">UDS Conversion</td><td colspan="3">ESD Cnversion</td></tr>
<tr><td colspan="3">$\text{UDS\_dec} = \left(\frac{180}{4294967294} * \text{LDS\_int}\right)$
<i>To UDS:</i>
- UDS = (double)(180/0xFFFFFFFE * LDS)
<i>To LDS:</i>
- LDS = (int32)round((0xFFFFFFFE/180 * UDS))</td><td colspan="3">$\text{ESD\_dec} = \left(\frac{180}{4294967294} * \text{LDS\_int}\right)$
<i>To ESD:</i>
- Convert LDS to decimal.
- Convert decimal to ASCII.
<i>To LDS:</i>
- Convert ASCII to decimal.
- Map decimal to int32.</td></tr>
</table>

6.13.1 Sensor Latitude

Latitude is the angular distance north or south of the earth's equator, measured in degrees along a meridian. Generated from GPS/INS information and based on the WGS84 coordinate system.

6.14 Key 14: Sensor Longitude Conversion

LDS	14	LDS Name	Sensor Longitude
UDS Mirror of LDS Item	**Units**	**Range**	**Format**
TBD	Degrees	+/- 180	int32

Notes

- Sensor Longitude. Based on WGS84 ellipsoid.
- Map -(2^31-1)..(2^31-1) to +/-180.
- Use -(2^31) as an "error" indicator.
- -(2^31) = 0x80000000.
- Resolution: ~84 nano degrees.

$$\mathtt{LDS\_dec} = \left(\frac{\mathtt{LDS\_range}}{\mathtt{int\_range}} * \mathtt{LDS\_int}\right)$$

UDS	06 0E 2B 34 01 01 01 03 07 01 02 01 02 06 02 00	ESD	So
UDS Name	Device Longitude	ESD Name	Sensor Longitude

Units	Range	Format	Units	Range	Format
Degrees	+/- 180	Double	Degrees	+/- 180.00	PDDDMMSST

Notes	Notes
- Specifies a sensor's geographic location in decimal degrees of longitude. - Positive values indicate eastern hemisphere. - Negative values indicate western hemisphere.	- Longitude of the aircraft. + Means East Longitude. All Longitude coordinates use WGS84.

UDS Conversion

$$\mathtt{UDS\_dec} = \left(\frac{360}{4294967294} * \mathtt{LDS\_int}\right)$$

To UDS:

- UDS = (double)(360/0xFFFFFFFE * LDS)

To LDS:

- LDS = (int32)round(0xFFFFFFFE/360 * UDS)

ESD Cnversion

$$\mathtt{ESD\_dec} = \left(\frac{360}{4294967294} * \mathtt{LDS\_int}\right)$$

To ESD:

- Convert LDS to decimal.
- Convert decimal to ASCII.

To LDS:

- Convert ASCII to decimal.
- Map decimal to int32.

6.14.1 Example Sensor Longitude

Longitude is the angular distance on the earth's surface, measured east or west from the prime meridian at Greenwich, England, to the meridian passing through a position of interest. Generated from GPS/INS information and based on the WGS84 coordinate system.

6.15 Key 15: Sensor True Altitude Conversion

LDS	15	LDS Name	Sensor True Altitude

UDS Mirror of LDS Item	Units	Range	Format
TBD	Meters	-900..19000	uint16

Notes

- Altitude of sensor as measured from Mean Sea Level (MSL).
- Map 0..(2^16-1) to -900..19000 meters.
- 1 meter = 3.2808399 feet.
- Resolution: ~0.3 meters.

$$\text{LDS\_dec} = \left(\frac{\text{LDS\_range}}{\text{uint\_range}} * \text{LDS\_int}\right) - \text{Offset}$$

UDS	06 0E 2B 34 01 01 01 01 07 01 02 01 02 02 00 00	ESD	Sl
UDS Name	Device Altitude	ESD Name	Sensor Altitude

Units	Range	Format	Units	Range	Format
Meters	Float	Float	Feet	+/- 0..99,999	PN

Notes	Notes
- Altitude of sensor as measured from Mean Sea Level (MSL), (default metres).	- Altitude of the aircraft (MSL).

UDS Conversion

$$\text{UDS\_dec} = \left(\frac{19900}{65535} * \text{LDS\_uint}\right) - 900$$

To UDS:

- UDS = (float)((19900/0xFFFF) * LDS - 900)

To LDS:

- LDS = (uint16)round(0xFFFF/19900 * (UDS + 900))

ESD Cnversion

$$\text{ESD\_dec} = \left(\frac{19900}{65535} * \text{LDS\_uint} - 900\right) * \frac{3.2808399\ \text{ft}}{1\ \text{m}}$$

To ESD:

- Convert LDS to decimal.
- Account for units.
- Convert decimal to ASCII.

To LDS:

- Convert ESD ASCII to decimal.
- Account for units.
- Map decimal to uint16.

6.15.1 Sensor True Altitude

True Altitude is the true vertical distance above mean sea level. Measurement is GPS derived.

6.16 Key 16: Sensor Horizontal Field of View Conversion

LDS	16	LDS Name	Sensor Horizontal Field of View
UDS Mirror of LDS Item	**Units**	**Range**	**Format**
TBD	Degrees	0..180	uint16

Notes

- Horizontal field of view of selected imaging sensor.
- Map 0..(2^16-1) to 0..180.
- Resolution: ~2.7 milli degrees.

$$\text{LDS\_dec} = \left(\frac{\text{LDS range}}{\text{uint\_range}} * \text{LDS\_uint}\right)$$

UDS	06 0E 2B 34 01 01 01 02 04 20 02 01 01 08 00 00
UDS Name	Field of View (FOV-Horizontal)

Units	Range	Format
Degrees	0..180	Float

Notes

- Sensor Horizontal field of view.

UDS Conversion

$$\text{UDS\_dec} = \left(\frac{180}{65535} * \text{LDS\_uint}\right)$$

To UDS:

- UDS = (float)(180/0xFFFF * LDS)

To LDS:

- LDS = (uint16)round((0xFFFF/180 * UDS))

ESD	Fv
ESD Name	Field of View

Units	Range	Format
Degrees	0..180.00	DDD.HH

Notes

- Angle of view of the lens on the selected camera. Horizontal, across baseline of image, projected onto the terrain (flat terrain model at DTED or other best available elevation data).

ESD Cnversion

$$\text{ESD\_dec} = \left(\frac{180}{65535} * \text{LDS\_uint}\right)$$

To ESD:

- Convert LDS to decimal.
- Convert decimal to ASCII.

To LDS:

- Convert ESD ASCII to decimal.
- Map decimal to uint16.

6.16.1 Sensor Horizontal Field of View

The field of view of a lens is defined as the angle over the focal plane where objects are recorded on a film or electro-optical sensor. Field of view is dependent upon the focal length of the lens, and the physical size of the sensor. Typical imaging devices have a square or rectangular imaging sensor. The image (or sequence of images) is typically captured as a square or rectangle and displayed to a user with image edges perpendicular to level sight.

The distance between left edge and right edge is represented as an angle in the horizontal field of view metadata item. Refer to the figure below:

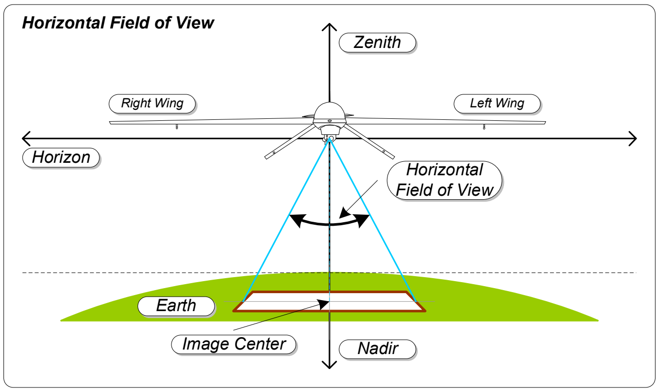

Figure 6-6: Horizontal Field of View

6.17 Key 17: Sensor Vertical Field of View Conversion

<table>
<tr><td>LDS</td><td colspan="2">17</td><td>LDS Name</td><td colspan="2">Sensor Vertical Field of View</td></tr>
<tr><td colspan="3">UDS Mirror of LDS Item</td><td>Units</td><td>Range</td><td>Format</td></tr>
<tr><td colspan="3">TBD</td><td>Degrees</td><td>0..180</td><td>uint16</td></tr>
<tr><td colspan="6">Notes</td></tr>
<tr><td colspan="3">- Vertical field of view of selected imaging sensor.
- Map 0..(2^16-1) to 0..180.
- Resolution: ~2.7 milli degrees.</td><td colspan="3">$LDS\_dec = \left(\frac{LDS\_range}{uint\_range} * LDS\_uint\right)$</td></tr>
<tr><td>UDS</td><td colspan="2">x</td><td>ESD</td><td colspan="2">x</td></tr>
<tr><td>UDS Name</td><td colspan="2">x</td><td>ESD Name</td><td colspan="2">x</td></tr>
<tr><td>Units</td><td>Range</td><td>Format</td><td>Units</td><td>Range</td><td>Format</td></tr>
<tr><td>x</td><td>x</td><td>x</td><td>x</td><td>x</td><td>x</td></tr>
<tr><td colspan="3">Notes</td><td colspan="3">Notes</td></tr>
<tr><td colspan="3">- x</td><td colspan="3">- x</td></tr>
<tr><td colspan="3">UDS Conversion</td><td colspan="3">ESD Cnversion</td></tr>
<tr><td colspan="3">x
To UDS:
- x
To LDS:
- x</td><td colspan="3">x
To ESD:
- x
To LDS:
- x</td></tr>
</table>

6.17.1 Sensor Vertical Field of View

The field of view of a lens is defined as the angle over the focal plane where objects are recorded on a film or electro-optical sensor. Field of view is dependent upon the focal length of the lens, and the physical size of the sensor. Typical imaging devices have a square or rectangular imaging sensor. The image (or sequence of images) is typically captured as a square or rectangle and displayed to a user with image edges perpendicular to level sight.

The distance between top edge and bottom edge is represented as an angle in the vertical field of view metadata item. Refer to the figure below:

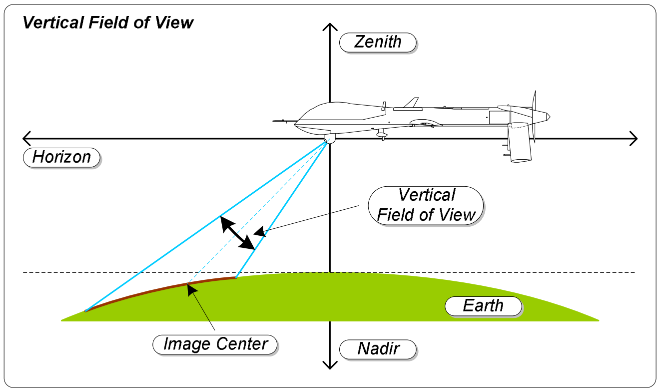

Figure 6-7: Vertical Field of View

6.18 Key 18: Sensor Relative Azimuth Angle Conversion

LDS	18	LDS Name	Sensor Relative Azimuth Angle
UDS Mirror of LDS Item	Units	Range	Format
TBD	Degrees	0..360	uint32

Notes

- Relative rotation angle of sensor to aircraft platform in azimuth. Rotation angle between aircraft fuselage chord and camera pointing direction as seen from above the platform.
- Map 0..(2^32-1) to 0..360.
- Resolution: ~84 nano degrees.

$$\mathrm{LDS\_dec} = \left(\frac{\mathrm{LDS\_range}}{\mathrm{uint\_range}} * \mathrm{LDS\_uint}\right)$$

UDS	x	ESD	x
UDS Name	x	ESD Name	x

Units	Range	Format	Units	Range	Format
x	x	x	x	x	x

Notes	Notes
- x	- x

UDS Conversion	ESD Cnversion
x	x
To UDS: - x *To LDS:* - x	*To ESD:* - x *To LDS:* - x

6.18.1 Example Sensor Relative Azimuth Angle

The relative rotation angle of the sensor is the angle formed between the line made by the fuselage and the sensor pointing direction in azimuth. Refer to the figure below:

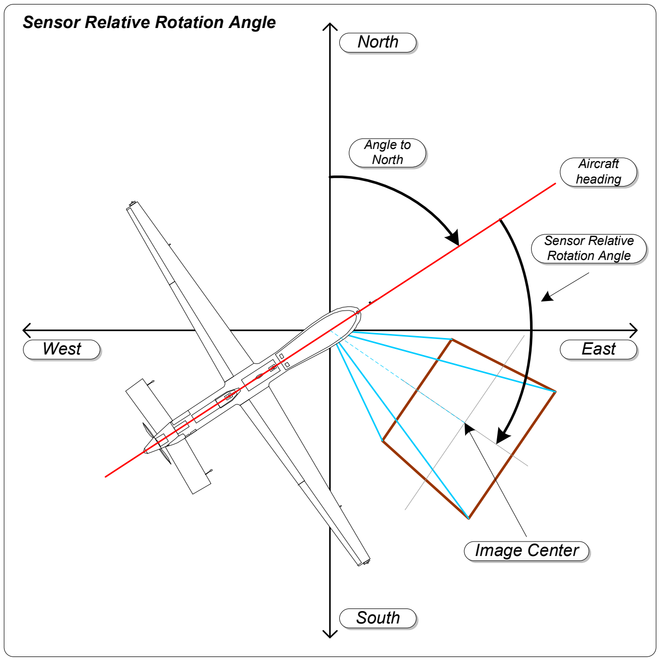

Figure 6-8: Relative Rotation Angle

6.19 Key 19: Sensor Relative Depression Angle Conversion

LDS	19	**LDS Name**	Sensor Relative Depression Angle

UDS Mirror of LDS Item	**Units**	**Range**	**Format**
TBD	Degrees	+/- 180	int32

Notes	
- Relative Depression Angle of sensor to aircraft platform. Level flight with camera pointing forward is zero degrees. Negative angles down. - Map -(2^31-1)..(2^31-1) to +/-180. - Use -(2^31) as an "error" indicator. - -(2^31) = 0x80000000. - Res: ~84 ndeg.	$\mathrm{LDS\_dec} = \left(\frac{\mathrm{LDS\_range}}{\mathrm{int\_range}} * \mathrm{LDS\_int}\right)$

UDS	x		**ESD**	x	
UDS Name	x		**ESD Name**	x	
Units	**Range**	**Format**	**Units**	**Range**	**Format**
x	x	x	x	x	x
Notes			**Notes**		
- x			- x		
UDS Conversion			**ESD Cnversion**		
x *To UDS:* - x *To LDS:* - x			x *To ESD:* - x *To LDS:* - x		

6.19.1 Sensor Relative Depression Angle

The relative depression angle of the sensor to the aircraft is the downward (or upward) pointing angle of the camera sensor relative to the plane of level flight. Refer to the figure below:

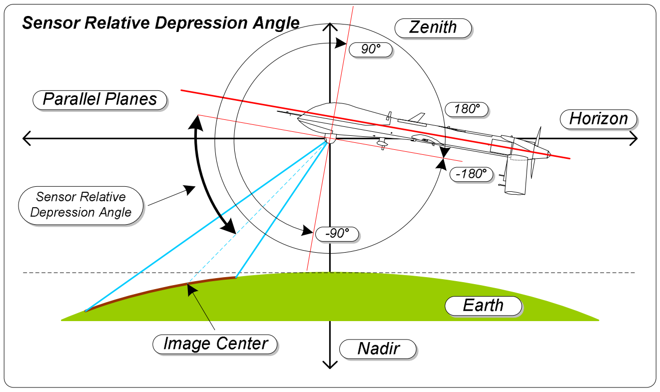

Figure 6-9: Sensor Relative Depression Angle

6.20 Key 20: Sensor Relative Roll Angle Conversion

LDS	20	**LDS Name**	Sensor Relative Roll Angle
UDS Mirror of LDS Item	**Units**	**Range**	**Format**
TBD	Degrees	0..360	uint32
Notes			
- Relative roll angle of sensor to aircraft platform. Twisting angle of camera about lens axis. Top of image is zero degrees. Positive angles are clockwise when looking from behind camera. - Map 0..(2^32-1) to 0..360. - Resolution: ~84 nano degrees.	$LDS\_dec = \left(\frac{LDS\_range}{uint\_range} * LDS\_uint\right)$		

UDS	x		**ESD**	x	
UDS Name	x		**ESD Name**	x	
Units	**Range**	**Format**	**Units**	**Range**	**Format**
x	x	x	x	x	x
Notes			**Notes**		
- x			- x		
UDS Conversion			**ESD Cnversion**		
x *To UDS:* - x *To LDS:* - x			x *To ESD:* - x *To LDS:* - x		

6.20.1 Example Sensor Relative Roll Angle

Sensors that are able to rotate their camera about the lens axis make use of this sensor relative roll angle. A roll angle of zero degrees occurs when the top and bottom edges of the captured image lie perpendicular to the plane created by the sensor relative depression angle axis. Positive angles are clockwise when looking from behind the camera.

6.21 Key 21: Slant Range Conversion

LDS	21	**LDS Name**	Slant Range

UDS Mirror of LDS Item	Units	Range	Format
TBD	Meters	0..5,000,000	uint32

Notes	
- Slant range in meters. Distance to target. - Map 0..(2^32-1) to 0..5000000 meters. - 1 nautical mile (knot) = 1852 meters. - Resoluiton: ~1.2 milli meters.	$\text{LDS\_dec} = \left(\frac{\text{LDS range}}{\text{uint\_range}} * \text{LDS\_uint}\right)$

UDS	06 0E 2B 34 01 01 01 01 07 01 08 01 01 00 00 00	**ESD**	Sr
UDS Name	Slant Range	**ESD Name**	Slant Range

Units	Range	Format	Units	Range	Format
Meters	Float	Float	Knot	0..18.00	II.HH

Notes	Notes
- Distance from the sensor to the center point on ground of the framed subject (image) depicted in the captured essence, (default metres)	- Distance between the sensor and the target

UDS Conversion	ESD Cnversion
$\text{UDS\_dec} = \left(\frac{5000000}{4294967295} * \text{LDS\_uint}\right)$	$\text{ESD\_dec} = \left(\frac{5000000}{4294967295} * \text{LDS\_int}\right) * \frac{1852 \text{ knot}}{1 \text{ m}}$
To UDS: - UDS = (float)(5000000/0xFFFFFFFF * LDS) *To LDS:* - LDS = (uint32)round(0xFFFFFFFF/5000000 * UDS)	*To ESD:* - Convert LDS to decimal. - Account for units. - Convert knots to ASCII. *To LDS:* - Convert ESD ASCII to decimal. - Account for units. - Convert feet to uint32.

6.21.1 Example Sensor Slant Range

The slant range is the distance between the sensor and image center. Refer to the figure below.

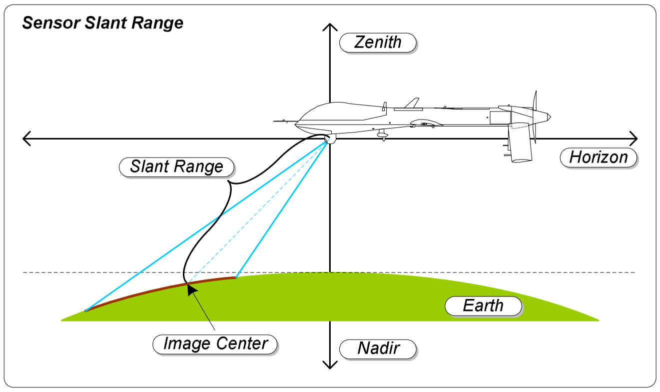

Figure 6-10: Sensor Slant Range

6.22 Key 22: Target Width Conversion

<table>
<tr><td>LDS</td><td colspan="2">22</td><td>LDS Name</td><td colspan="2">Target Width</td></tr>
<tr><td colspan="3">UDS Mirror of LDS Item</td><td>Units</td><td>Range</td><td>Format</td></tr>
<tr><td colspan="3">TBD</td><td>Meters</td><td>0..10000</td><td>uint16</td></tr>
<tr><td colspan="6">Notes</td></tr>
<tr><td colspan="3">- Target Width within sensor field of view.
- Map 0..(2^16-1) to 0..10000 meters.
- 1 meter = 3.2808399 feet.
- Resolution: ~.16 meters.</td><td colspan="3">LDS_dec = LDS_uint</td></tr>
<tr><td>UDS</td><td colspan="2">06 0E 2B 34 01 01 01 01
07 01 09 02 01 00 00 00</td><td>ESD</td><td colspan="2">Tw</td></tr>
<tr><td>UDS Name</td><td colspan="2">Target Width</td><td>ESD Name</td><td colspan="2">Target Width</td></tr>
<tr><td>Units</td><td>Range</td><td>Format</td><td>Units</td><td>Range</td><td>Format</td></tr>
<tr><td>Meters</td><td>Float</td><td>Float</td><td>Feet</td><td>0..99,999</td><td>N</td></tr>
<tr><td colspan="3">Notes</td><td colspan="3">Notes</td></tr>
<tr><td colspan="3">- Horizontal half width of the target frame image; used to compute the four corner points of the frame, (default metres)</td><td colspan="3">- Width of the EO/IR Payloads field of view on the ground</td></tr>
<tr><td colspan="3">UDS Conversion</td><td colspan="3">ESD Cnversion</td></tr>
<tr><td colspan="3">$\mathrm{UDS\_dec} = \left(\frac{10000}{65535} * \mathrm{LDS\_uint}\right)$
<i><u>To UDS:</u></i>
- UDS = (float)(10000/0xFFFF * LDS)
<i><u>To LDS:</u></i>
- LDS = (uint32)round(0xFFFF/10000 * UDS)</td><td colspan="3">$\mathrm{ESD\_dec} = \left(\frac{10000}{65535} * \mathrm{LDS\_int}\right) * \frac{3.2808399\ \mathrm{ft}}{1\ \mathrm{m}}$
<i><u>To ESD:</u></i>
- Convert LDS to decimal.
- Account for units.
- Convert feet to ASCII.
<i><u>To LDS:</u></i>
- Convert ESD ASCII to decimal.
- Account for units.
- Convert meters to uint32.</td></tr>
</table>

6.22.1 Example Sensor Target Width

The target width is the linear ground distance between the center of both sides of the captured image. Refer to figure below.

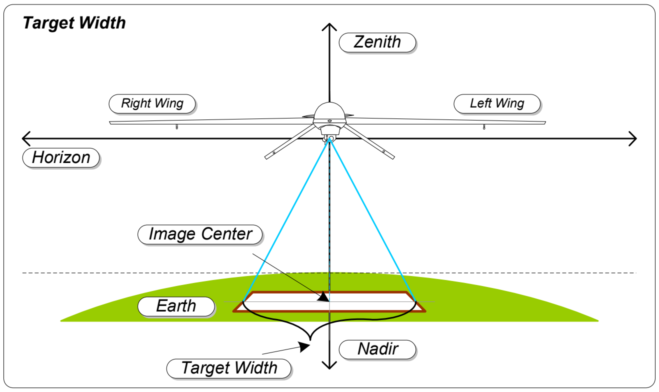

Figure 6-11: Target Width

6.23 Key 23: Frame Center Latitude Conversion

LDS	23	**LDS Name**	Frame Center Latitude

UDS Mirror of LDS Item	Units	Range	Format
TBD	Degrees	+/- 90	int32

Notes

- Terrain Latitude of frame center. Based on WGS84 ellipsoid.
- Map -(2^31-1)..(2^31-1) to +/-90.
- Use -(2^31) as an "error" indicator.
- -(2^31) = 0x80000000.
- Resolution: ~42 nano degrees.

$$\text{LDS\_dec} = \left(\frac{\text{LDS\_range}}{\text{int\_range}} * \text{LDS\_int}\right)$$

UDS	06 0E 2B 34 01 01 01 01 07 01 02 01 03 02 00 00	**ESD**	Ta
UDS Name	Frame Center Latitude	**ESD Name**	Target Latitude

Units	Range	Format	Units	Range	Format
Degrees	+/- 90	Double	Degrees	+/- 90.0	PDDMMSST

Notes	Notes
- Specifies the video frame center point geographic location in decimal degrees of latitude. - Positive values indicate northern hemisphere. - Negative values indicate southern hemisphere.	- Latitude of the EO/IR payload's aimpoint on the ground. + Means North lattitude. All latitude coordinates use WGS84.

UDS Conversion

$$\text{UDS\_dec} = \left(\frac{180}{4294967294} * \text{LDS\_int}\right)$$

To UDS:

- UDS = (double)(180/0xFFFFFFFE * LDS)

To LDS:

- LDS = (int32)round(0xFFFFFFFE/180 * UDS)

ESD Cnversion

$$\text{ESD\_dec} = \left(\frac{180}{4294967294} * \text{LDS\_int}\right)$$

To ESD:

- Convert LDS to decimal.
- Convert decimal to ASCII.

To LDS:

- Convert ASCII to decimal.
- Map decimal to int32.

6.23.1 Frame Center Latitude

The center of the captured image or image sequence has a real earth coordinate represented by a latitude-longitude-altitude triplet. Frame centers that lie above the horizon do not correspond to a point on the earth and should either not be reported, or be reported as an “error”.

6.24 Key 24: Frame Center Longitude Conversion

LDS	24	LDS Name	Frame Center Longitude
UDS Mirror of LDS Item	Units	Range	Format
TBD	Degrees	+/- 180	int32
Notes			
- Terrain Longitude of frame center. Based on WGS84 ellipsoid. - Map -(2^31-1)..(2^31-1) to +/-180. - Use -(2^31) as an "error" indicator. - -(2^31) = 0x80000000. - Resolution: ~84 nano degrees.	$LDS\_dec = \left(\frac{LDS\_range}{int\_range} * LDS\_int\right)$		

UDS	06 0E 2B 34 01 01 01 01 07 01 02 01 03 04 00 00		ESD	To	
UDS Name	Frame Center Longitude		ESD Name	Target Longitude	
Units	Range	Format	Units	Range	Format
Degrees	+/- 180	Double	Degrees	+/- 180.00	PDDDMMSST
Notes			Notes		
- Specifies the video frame center point geographic location in decimal degrees of longitude. - Positive values indicate eastern hemisphere. - Negative values indicate western hemisphere.			- Longitude of the EO/IR payload's aimpoint on the ground. + Means East longitude. All longitude coordinates use WGS84.		
UDS Conversion			ESD Cnversion		
$UDS\_dec = \left(\frac{180}{4294967294} * LDS\_int\right)$ *To UDS:* - UDS = (double)(180/0xFFFFFFFE * LDS) *To LDS:* - LDS = (int32)round(0xFFFFFFFE/180 * UDS)			$ESD\_dec = \left(\frac{180}{4294967294} * LDS\_int\right)$ *To ESD:* - Convert LDS to decimal. - Convert decimal to ASCII. *To LDS:* - Convert ASCII to decimal. - Map decimal to int32.		

6.24.1 Example Sensor Frame Center Longitude

The center of the captured image or image sequence has a real earth coordinate represented by a latitude-longitude-altitude triplet. Frame centers that lie above the horizon do not correspond to a point on the earth and should either not be reported, or be reported as an “error”.

6.25 Key 25: Frame Center Elevation Conversion

<table>
<tr><td>LDS</td><td colspan="2">25</td><td>LDS Name</td><td colspan="2">Frame Center Elevation</td></tr>
<tr><td colspan="3">UDS Mirror of LDS Item</td><td>Units</td><td>Range</td><td>Format</td></tr>
<tr><td colspan="3">TBD</td><td>Meters</td><td>-900..19000</td><td>uint16</td></tr>
<tr><td colspan="6">Notes</td></tr>
<tr><td colspan="3">- Terrain elevation at frame center.
- Map 0..(2^16-1) to -900..19000 meters.
- Resolution: ~0.3 meters.</td><td colspan="3">LDS_dec = (LDS_uint - Offset)</td></tr>
<tr><td>UDS</td><td colspan="2">06 0E 2B 34 01 01 01 06
07 01 02 03 10 00 00 00</td><td>ESD</td><td colspan="2">x</td></tr>
<tr><td>UDS Name</td><td colspan="2">Frame Center Elevation</td><td>ESD Name</td><td colspan="2">x</td></tr>
<tr><td>Units</td><td>Range</td><td>Format</td><td>Units</td><td>Range</td><td>Format</td></tr>
<tr><td>x</td><td>x</td><td>x</td><td>x</td><td>x</td><td>x</td></tr>
<tr><td colspan="3">Notes</td><td colspan="3">Notes</td></tr>
<tr><td colspan="3">- Check latest released dictionary.</td><td colspan="3">- x</td></tr>
<tr><td colspan="3">UDS Conversion</td><td colspan="3">ESD Cnversion</td></tr>
<tr><td colspan="3">x
<i><u>To UDS:</u></i>
- x
<i><u>To LDS:</u></i>
- x</td><td colspan="3">x
<i><u>To ESD:</u></i>
- x
<i><u>To LDS:</u></i>
- x</td></tr>
</table>

6.25.1 Example Frame Center Elevation

The center of the captured image or image sequence has a real earth coordinate represented by a latitude-longitude-altitude triplet. Frame centers that lie above the horizon do not correspond to a point on the earth and should either not be reported, or be reported as an “error”.

6.26 Key 26: Corner Latitude Point 1 Conversion

LDS	26	**LDS Name**	Corner Latitude Point 1

UDS Mirror of LDS Item	Units	Range	Format
TBD	Degrees	+/- 90	int16

Notes	
- Frame Latitude, upper left corner. Based on WGS84 ellipsoid. - Map -(2^15-1)..(2^15-1) to +/-90. - Use -(2^15) as an "error" indicator. - -(2^15) = 0x8000. - Resolution: ~2.7 milli degrees.	$\text{LDS\_dec} = \left(\frac{\text{LDS\_range}}{\text{int\_range}} * \text{LDS\_int}\right)$

UDS	06 0E 2B 34 01 01 01 03 07 01 02 01 03 07 01 00	**ESD**	Rg
UDS Name	Corner Latitude Point 1 (Decimal Degrees)	**ESD Name**	SAR Latitude 4

Units	Range	Format	Units	Range	Format
Degrees	+/- 90	Double	Degrees	+/- 90.0	PDDMMSST

Notes	Notes
- Latitude coordinate of corner 1 of an image or bounding rectangle. - Positive (+) is northern hemisphere. - Negative (-) is southern hemisphere.	- The latitude of the upper left corner of the SAR image box.

UDS Conversion	ESD Cnversion
$\text{UDS\_dec} = \left(\frac{180}{65534} * \text{LDS\_int}\right)$	$\text{ESD\_dec} = \left(\frac{180}{65534} * \text{LDS\_int}\right)$
To UDS: - UDS = (double)(180/0xFFFE * LDS) ***To LDS:*** - LDS = (int32)round(0xFFFE/180 * UDS)	***To ESD:*** - Convert LDS to decimal. - Convert decimal to ASCII. ***To LDS:*** - Convert ASCII to decimal. - Map decimal to int16.

6.26.1 Corner Latitude Point 1

The corner points of the captured image or image sequence have a real earth coordinate represented by a latitude-longitude pair. Corner points that lie above the horizon do not correspond to a point on the earth and should either not be reported, or be reported as an “error”.

Corner point 1 is the upper left corner of the captured image.

6.27 Key 27: Corner Longitude Point 1 Conversion

LDS	27	LDS Name	Corner Longitude Point 1

UDS Mirror of LDS Item	Units	Range	Format
TBD	Degrees	+/- 180	int16

Notes

- Frame Longitude, upper left corner. Based on WGS84 ellipsoid.
- Map -(2^15-1)..(2^15-1) to +/-180.
- Use -(2^15) as an "error" indicator.
- -(2^15) = 0x8000.
- Resolution: ~5.5 milli degrees.

$$LDS\_dec = \left(\frac{LDS\_range}{int\_range} * LDS\_int\right)$$

UDS	06 0E 2B 34 01 01 01 03 07 01 02 01 03 0B 01 00	ESD	Rh
UDS Name	Corner Longitude Point 1 (Decimal Degrees)	ESD Name	SAR Longitude 4

Units	Range	Format	Units	Range	Format
Degrees	+/- 180	Double	Degrees	+/- 180.0	PDDDMMSST

Notes	Notes
- Longitude coordinate of corner 1 of an image or bounding rectangle. - Positive (+) is eastern hemisphere. - Negative (-) is western hemisphere.	- The longitude of the upper left corner of the SAR image box.

UDS Conversion

$$UDS\_dec = \left(\frac{360}{65534} * LDS\_int\right)$$

To UDS:
- UDS = (double)(360/0xFFFE * LDS)

To LDS:
- LDS = (int32)round(0xFFFE/360 * UDS)

ESD Cnversion

$$ESD\_dec = \left(\frac{360}{65534} * LDS\_int\right)$$

To ESD:
- Convert LDS to decimal.
- Convert decimal to ASCII.

To LDS:
- Convert ASCII to decimal.
- Map decimal to int16.

6.27.1 Corner Longitude Point 1

The corner points of the captured image or image sequence have a real earth coordinate represented by a latitude-longitude pair. Corner points that lie above the horizon do not correspond to a point on the earth and should either not be reported, or be reported as an “error”.

Corner point 1 is the upper left corner of the captured image.

6.28 Key 28: Corner Latitude Point 2 Conversion

LDS	28	LDS Name	Corner Latitude Point 2

UDS Mirror of LDS Item	Units	Range	Format
TBD	Degrees	+/- 90	int16

Notes	
- Frame Latitude, upper right corner. Based on WGS84 ellipsoid. - Map -(2^15-1)..(2^15-1) to +/-90. - Use -(2^15) as an "error" indicator. - -(2^15) = 0x8000. - Resolution: ~2.7 milli degrees.	$\text{LDS\_dec} = \left(\frac{\text{LDS\_range}}{\text{int\_range}} * \text{LDS\_int}\right)$

UDS	06 0E 2B 34 01 01 01 03 07 01 02 01 03 08 01 00	ESD	Ra
UDS Name	Corner Latitude Point 2 (Decimal Degrees)	ESD Name	SAR Latitude 1

Units	Range	Format	Units	Range	Format
Degrees	+/- 90	Double	Degrees	+/- 90.0	PDDMMSST

Notes	Notes
- Latitude coordinate of corner 2 of an image or bounding rectangle. - Positive (+) is northern hemisphere. - Negative (-) is southern hemisphere.	- The latitude of the upper right corner of the SAR image box.

UDS Conversion	ESD Cnversion
$\text{UDS\_dec} = \left(\frac{180}{65534} * \text{LDS\_int}\right)$	$\text{ESD\_dec} = \left(\frac{180}{65534} * \text{LDS\_int}\right)$
To UDS: - UDS = (double)(180/0xFFFE * LDS) ***To LDS:*** - LDS = (int32)round(0xFFFE/180 * UDS)	***To ESD:*** - Convert LDS to decimal. - Convert decimal to ASCII. ***To LDS:*** - Convert ASCII to decimal. - Map decimal to int16.

6.28.1 Corner Latitude Point 2

The corner points of the captured image or image sequence have a real earth coordinate represented by a latitude-longitude pair. Corner points that lie above the horizon do not correspond to a point on the earth and should either not be reported, or be reported as an “error”.

Corner point 2 is the upper right corner of the captured image.

6.29 Key 29: Corner Longitude Point 2 Conversion

LDS	29	**LDS Name**	Corner Longitude Point 2

UDS Mirror of LDS Item	Units	Range	Format
TBD	Degrees	+/- 180	int16

Notes	
- Frame Longitude, upper right corner. Based on WGS84 ellipsoid. - Map -(2^15-1)..(2^15-1) to +/-180. - Use -(2^15) as an "error" indicator. - -(2^15) = 0x8000. - Resolution: ~5.5 milli degrees.	$LDS\_dec = \left(\frac{LDS\_range}{int\_range} * LDS\_int\right)$

UDS	06 0E 2B 34 01 01 01 03 07 01 02 01 03 0C 01 00	**ESD**	Rb
UDS Name	Corner Longitude Point 2 (Decimal Degrees)	**ESD Name**	SAR Longitude 1

Units	Range	Format	Units	Range	Format
Degrees	+/- 180	Double	Degrees	+/- 180.0	PDDDMMSST

Notes	Notes
- Longitude coordinate of corner 2 of an image or bounding rectangle. - Positive (+) is eastern hemisphere. - Negative (-) is western hemisphere.	- The longitude of the upper right corner of the SAR image box.

UDS Conversion	ESD Cnversion
$UDS\_dec = \left(\frac{360}{65534} * LDS\_int\right)$	$ESD\_dec = \left(\frac{360}{65534} * LDS\_int\right)$
To UDS: - UDS = (double)(360/0xFFFE * LDS) *To LDS:* - LDS = (int32)round(0xFFFE/360 * UDS)	*To ESD:* - Convert LDS to decimal. - Convert decimal to ASCII. *To LDS:* - Convert ASCII to decimal. - Map decimal to int16.

6.29.1 Corner Longitude Point 2

The corner points of the captured image or image sequence have a real earth coordinate represented by a latitude-longitude pair. Corner points that lie above the horizon do not correspond to a point on the earth and should either not be reported, or be reported as an “error”.

Corner point 2 is the upper right corner of the captured image.

6.30 Key 30: Corner Latitude Point 3 Conversion

LDS	30	**LDS Name**	Corner Latitude Point 3

UDS Mirror of LDS Item	Units	Range	Format
TBD	Degrees	+/- 90	int16

Notes

- Frame Latitude, lower right corner. Based on WGS84 ellipsoid.
- Map -(2^15-1)..(2^15-1) to +/-90.
- Use -(2^15) as an "error" indicator.
- -(2^15) = 0x8000.
- Resolution: ~2.7 milli degrees.

$$\text{LDS\_dec} = \left(\frac{\text{LDS\_range}}{\text{int\_range}} * \text{LDS\_int}\right)$$

UDS	06 0E 2B 34 01 01 01 03 07 01 02 01 03 09 01 00	**ESD**	Rc
UDS Name	Corner Latitude Point 3 (Decimal Degrees)	**ESD Name**	SAR Latitude 2

Units	Range	Format	Units	Range	Format
Degrees	+/- 90	Double	Degrees	+/- 90.0	PDDMMSST

Notes	Notes
- Latitude coordinate of corner 3 of an image or bounding rectangle. - Positive (+) is northern hemisphere. - Negative (-) is southern hemisphere.	- The latitude of the lower right corner of the SAR image box.

UDS Conversion

$$\text{UDS\_dec} = \left(\frac{180}{65534} * \text{LDS\_int}\right)$$

To UDS:
- UDS = (double)(180/0xFFFE * LDS)

To LDS:
- LDS = (int32)round(0xFFFE/180 * UDS)

ESD Cnversion

$$\text{ESD\_dec} = \left(\frac{180}{65534} * \text{LDS\_int}\right)$$

To ESD:
- Convert LDS to decimal.
- Convert decimal to ASCII.

To LDS:
- Convert ASCII to decimal.
- Map decimal to int16.

6.30.1 Corner Latitude Point 3

The corner points of the captured image or image sequence have a real earth coordinate represented by a latitude-longitude pair. Corner points that lie above the horizon do not correspond to a point on the earth and should either not be reported, or be reported as an “error”.

Corner point 3 is the lower right corner of the captured image.

6.31 Key 31: Corner Longitude Point 3 Conversion

LDS	31	LDS Name	Corner Longitude Point 3

UDS Mirror of LDS Item	Units	Range	Format
TBD	Degrees	+/- 180	int16

Notes

- Frame Longitude, lower right corner. Based on WGS84 ellipsoid.
- Map -(2^15-1)..(2^15-1) to +/-180.
- Use -(2^15) as an "error" indicator.
- -(2^15) = 0x8000.
- Resolution: ~5.5 milli degrees.

$$\text{LDS\_dec} = \left(\frac{\text{LDS\_range}}{\text{int\_range}} * \text{LDS\_int}\right)$$

UDS	06 0E 2B 34 01 01 01 03 07 01 02 01 03 0D 01 00	ESD	Rd
UDS Name	Corner Longitude Point 3 (Decimal Degrees)	ESD Name	SAR Longitude 2

Units	Range	Format	Units	Range	Format
Degrees	+/- 180	Double	Degrees	+/- 180.0	PDDDMMSST

Notes	Notes
- Longitude coordinate of corner 3 of an image or bounding rectangle. - Positive (+) is eastern hemisphere. - Negative (-) is western hemisphere.	- The longitude of the lower right corner of the SAR image box.

UDS Conversion

$$\text{UDS\_dec} = \left(\frac{360}{65534} * \text{LDS\_int}\right)$$

To UDS:
- UDS = (double)(360/0xFFFE * LDS)

To LDS:
- LDS = (int32)round(0xFFFE/360 * UDS)

ESD Cnversion

$$\text{ESD\_dec} = \left(\frac{360}{65534} * \text{LDS\_int}\right)$$

To ESD:
- Convert LDS to decimal.
- Convert decimal to ASCII.

To LDS:
- Convert ASCII to decimal.
- Map decimal to int16.

6.31.1 Corner Longitude Point 3

The corner points of the captured image or image sequence have a real earth coordinate represented by a latitude-longitude pair. Corner points that lie above the horizon do not correspond to a point on the earth and should either not be reported, or be reported as an “error”.

Corner point 3 is the lower right corner of the captured image.

6.32 Key 32: Corner Latitude Point 4 Conversion

LDS	32	**LDS Name**	Corner Latitude Point 4

UDS Mirror of LDS Item	Units	Range	Format
TBD	Degrees	+/- 90	int16

Notes

- Frame Latitude, lower left corner. Based on WGS84 ellipsoid.
- Map -(2^15-1)..(2^15-1) to +/-90.
- Use -(2^15) as an "error" indicator.
- -(2^15) = 0x8000.
- Resolution: ~2.7 milli degrees.

$$\text{LDS\_dec} = \left(\frac{\text{LDS\_range}}{\text{int\_range}} * \text{LDS\_int}\right)$$

UDS	06 0E 2B 34 01 01 01 03 07 01 02 01 03 0A 01 00	**ESD**	Re
UDS Name	Corner Latitude Point 4 (Decimal Degrees)	**ESD Name**	SAR Latitude 3

Units	Range	Format	Units	Range	Format
Degrees	+/- 90	Double	Degrees	+/- 90.0	PDDMMSST

Notes	Notes
- Latitude coordinate of corner 4 of an image or bounding rectangle. - Positive (+) is northern hemisphere. - Negative (-) is southern hemisphere.	- The latitude of the lower left corner of the SAR image box.

UDS Conversion

$$\text{UDS\_dec} = \left(\frac{180}{65534} * \text{LDS\_int}\right)$$

To UDS:

- UDS = (double)(180/0xFFFE * LDS)

To LDS:

- LDS = (int32)round(0xFFFE/180 * UDS)

ESD Cnversion

$$\text{ESD\_dec} = \left(\frac{180}{65534} * \text{LDS\_int}\right)$$

To ESD:

- Convert LDS to decimal.
- Convert decimal to ASCII.

To LDS:

- Convert ASCII to decimal.
- Map decimal to int16.

6.32.1 Corner Latitude Point 4

The corner points of the captured image or image sequence have a real earth coordinate represented by a latitude-longitude pair. Corner points that lie above the horizon do not correspond to a point on the earth and should either not be reported, or be reported as an “error”.

Corner point 4 is the lower left corner of the captured image.

6.33 Key 33: Corner Longitude Point 4 Conversion

<table>
<tr><td>LDS</td><td colspan="2">33</td><td>LDS Name</td><td colspan="2">Corner Longitude Point 4</td></tr>
<tr><td colspan="3">UDS Mirror of LDS Item</td><td>Units</td><td>Range</td><td>Format</td></tr>
<tr><td colspan="3">TBD</td><td>Degrees</td><td>+/- 180</td><td>int16</td></tr>
<tr><td colspan="6">Notes</td></tr>
<tr><td colspan="3">- Frame Longitude, lower left corner. Based on WGS84 ellipsoid.
- Map -(2^15-1)..(2^15-1) to +/-180.
- Use -(2^151) as an "error" indicator.
- -(2^15) = 0x8000.
- Resolution: ~5.5 milli degrees.</td><td colspan="3">$LDS\_dec = \left(\frac{LDS\_range}{int\_range} * LDS\_int\right)$</td></tr>
<tr><td>UDS</td><td colspan="2">06 0E 2B 34 01 01 01 03
07 01 02 01 03 0E 01 00</td><td>ESD</td><td colspan="2">Rf</td></tr>
<tr><td>UDS Name</td><td colspan="2">Corner Longitude Point 4 (Decimal Degrees)</td><td>ESD Name</td><td colspan="2">SAR Longitude 3</td></tr>
<tr><td>Units</td><td>Range</td><td>Format</td><td>Units</td><td>Range</td><td>Format</td></tr>
<tr><td>Degrees</td><td>+/- 180</td><td>Double</td><td>Degrees</td><td>+/- 180.0</td><td>PDDDMMSST</td></tr>
<tr><td colspan="3">Notes</td><td colspan="3">Notes</td></tr>
<tr><td colspan="3">- Longitude coordinate of corner 4 of an image or bounding rectangle.
- Positive (+) is eastern hemisphere.
- Negative (-) is western hemisphere.</td><td colspan="3">- The longitude of the lower left corner of the SAR image box.</td></tr>
<tr><td colspan="3">UDS Conversion</td><td colspan="3">ESD Cnversion</td></tr>
<tr><td colspan="3">$UDS\_dec = \left(\frac{360}{65534} * LDS\_int\right)$
<i><u>To UDS:</u></i>
- UDS = (double)(360/0xFFFE * LDS)
<i><u>To LDS:</u></i>
- LDS = (int32)round(0xFFFE/360 * UDS)</td><td colspan="3">$ESD\_dec = \left(\frac{360}{65534} * LDS\_int\right)$
<i><u>To ESD:</u></i>
- Convert LDS to decimal.
- Convert decimal to ASCII.
<i><u>To LDS:</u></i>
- Convert ASCII to decimal.
- Map decimal to int16.</td></tr>
</table>

6.33.1 Corner Longitude Point 4

The corner points of the captured image or image sequence have a real earth coordinate represented by a latitude-longitude pair. Corner points that lie above the horizon do not correspond to a point on the earth and should either not be reported, or be reported as an “error”.

Corner point 4 is the lower left corner of the captured image.

6.34 Key 34: Icing Detected Conversion

<table>
<tr><td>LDS</td><td colspan="2">34</td><td>LDS Name</td><td colspan="2">Icing Detected</td></tr>
<tr><td colspan="3">UDS Mirror of LDS Item</td><td>Units</td><td>Range</td><td>Format</td></tr>
<tr><td colspan="3">TBD</td><td>Icing Code</td><td>0..2</td><td>uint8</td></tr>
<tr><td colspan="6">Notes</td></tr>
<tr><td colspan="3">- Flag for icing detected at aircraft location.
- 0: Detector off
- 1: No icing Detected
- 2: Icing Detected</td><td colspan="3">x</td></tr>
<tr><td>UDS</td><td colspan="2">Register</td><td>ESD</td><td colspan="2">Id</td></tr>
<tr><td>UDS Name</td><td colspan="2">x</td><td>ESD Name</td><td colspan="2">Icing Detected</td></tr>
<tr><td>Units</td><td>Range</td><td>Format</td><td>Units</td><td>Range</td><td>Format</td></tr>
<tr><td>x</td><td>x</td><td>x</td><td>Icing Code</td><td>0..2</td><td>N</td></tr>
<tr><td colspan="3">Notes</td><td colspan="3">Notes</td></tr>
<tr><td colspan="3">- x</td><td colspan="3">- Output of the aircrafts icing detector
- 0: Detector off
- 1: No icing detected
- 2: Icing detected</td></tr>
<tr><td colspan="3">UDS Conversion</td><td colspan="3">ESD Cnversion</td></tr>
<tr><td colspan="3">x
<i>To UDS:</i>
- x
<i>To LDS:</i>
- x</td><td colspan="3">x
<i>To ESD:</i>
- Convert string to ID code.
<i>To LDS:</i>
- Convert ID code to string.</td></tr>
</table>

6.34.1 Icing Detected

This metadata item signals when the icing sensor detects water forming on its vibrating probe.

6.35 Key 35: Wind Direction Conversion

<table>
<tr><td>LDS</td><td colspan="2">35</td><td>LDS Name</td><td colspan="2">Wind Direction</td></tr>
<tr><td colspan="3">UDS Mirror of LDS Item</td><td>Units</td><td>Range</td><td>Format</td></tr>
<tr><td colspan="3">TBD</td><td>Degrees</td><td>0..360</td><td>uint16</td></tr>
<tr><td colspan="6">Notes</td></tr>
<tr><td colspan="3">- Wind direction at aircraft location.
- Map 0..(2^16-1) to 0..360.
- Resolution: ~5.5 milli degrees.</td><td colspan="3">LDS_dec = $\left(\frac{\text{LDS\_range}}{\text{uint\_range}} * \text{LDS\_uint}\right)$</td></tr>
<tr><td>UDS</td><td colspan="2">x</td><td>ESD</td><td colspan="2">Wd</td></tr>
<tr><td>UDS Name</td><td colspan="2">x</td><td>ESD Name</td><td colspan="2">Wind Direction</td></tr>
<tr><td>Units</td><td>Range</td><td>Format</td><td>Units</td><td>Range</td><td>Format</td></tr>
<tr><td>x</td><td>x</td><td>x</td><td>Degrees</td><td>0..359</td><td>DDD</td></tr>
<tr><td colspan="3">Notes</td><td colspan="3">Notes</td></tr>
<tr><td colspan="3">- x</td><td colspan="3">- Direction (from North) from which the wind is blowing at the aircraft location</td></tr>
<tr><td colspan="3">UDS Conversion</td><td colspan="3">ESD Cnversion</td></tr>
<tr><td colspan="3">x
To UDS:
- x
To LDS:
- x</td><td colspan="3">ESD_dec = $\left(\frac{360}{65534} * \text{LDS\_uint}\right)$
To ESD:
- Convert LDS to decimal.
- Convert decimal to ASCII.
To LDS:
- Convert ESD ASCII to decimal.
- Map decimal to uint16.</td></tr>
</table>

6.35.1 Wind Direction

The direction the air body around the aircraft is traveling relative to true north.

6.36 Key 36: Wind Speed Conversion

LDS	36	**LDS Name**	Wind Speed
UDS Mirror of LDS Item	**Units**	**Range**	**Format**
TBD	Meters / Second	0..100	uint8
Notes			
- Wind speed at aircraft location. - Map 0..255 to 0..100 meters/second. - 1 m/s = 1.94384449 knots. - Resolution: ~0.4 meters / second.		$LDS\_dec = \left(\frac{LDS\_range}{uint\_range} * LDS\_uint\right)$	

UDS	x		**ESD**	Ws	
UDS Name	x		**ESD Name**	Wind Speed	
Units	**Range**	**Format**	**Units**	**Range**	**Format**
x	x	x	Knots	0..99	NN
Notes			**Notes**		
- x			- Wind Speed (relative to the Earth) at the aircraft location.		
UDS Conversion			**ESD Cnversion**		
x *To UDS:* - x *To LDS:* - x			$ESD\_dec = \left(\frac{100}{255} * LDS\_uint\right) * \frac{1.94384449knots}{1m/s}$ *To ESD:* - Convert LDS to decimal. - Account for units. - Convert knots to ASCII. *To LDS:* - Convert ESD ASCII to decimal. - Account for units. - Convert meters to uint8.		

6.36.1 Wind Speed

The speed of the body of air that surrounds the aircraft relative to the ground is captured in this wind speed metadata item.

6.37 Key 37: Static Pressure Conversion

LDS	37		LDS Name	Static Pressure	
UDS Mirror of LDS Item			Units	Range	Format
TBD			Millibar	0..5000	uint16
Notes					
- Static pressure at aircraft location. - Map 0..(2^16-1) to 0..5000 mbar. - 1 mbar = 0.0145037738 PSI. - Resolution: ~0.08 Millibar			LDS_dec = $\left(\frac{\text{LDS\_range}}{\text{uint\_range}} * \text{LDS\_uint}\right)$		
UDS	x		ESD	Ps	
UDS Name	x		ESD Name	Static Pressure	
Units	Range	Format	Units	Range	Format
x	x	x	PSI	0..99.99	DD.HH
Notes			Notes		
- x			- Static Pressure		
UDS Conversion			ESD Cnversion		
x *To UDS:* - x *To LDS:* - x			ESD_dec = $\left(\frac{5000}{65535} * \text{LDS\_int}\right) * \frac{0.0145037738\ \text{PSI}}{1\ \text{mbar}}$ *To ESD:* - Convert LDS to decimal. - Convert decimal to ASCII. *To LDS:* - Convert ESD ASCII to decimal. - Map decimal to uint16.		

6.37.1 Static Pressure

The static pressure is the pressure of the air that surrounds the aircraft. Static pressure is measured by a sensor mounted out of the air stream on the side of the fuselage. This is used with impact pressure to compute indicated airspeed, true airspeed, and density altitude.

6.38 Key 38: Density Altitude Conversion

<table>
<tr><td>LDS</td><td colspan="2">38</td><td>LDS Name</td><td colspan="2">Density Altitude</td></tr>
<tr><td colspan="3">UDS Mirror of LDS Item</td><td>Units</td><td>Range</td><td>Format</td></tr>
<tr><td colspan="3">TBD</td><td>Meters</td><td>-900..19000</td><td>uint16</td></tr>
<tr><td colspan="6">Notes</td></tr>
<tr><td colspan="3">- Density altitude at aircraft location. Relative aircraft performance metric based on outside air temperature, static pressure, and humidity.
- Map 0..(2^16-1) to -900..19000 meters.
- Offset = -900.
- 1 meter = 3.2808399 feet.
- Resolution: ~0.3 meters.</td><td colspan="3">$\text{LDS\_dec} = \left(\frac{\text{LDS\_range}}{\text{uint\_range}} * \text{LDS\_int}\right) - \text{Offset}$</td></tr>
<tr><td>UDS</td><td colspan="2">x</td><td>ESD</td><td colspan="2">Da</td></tr>
<tr><td>UDS Name</td><td colspan="2">x</td><td>ESD Name</td><td colspan="2">Density Altitude</td></tr>
<tr><td>Units</td><td>Range</td><td>Format</td><td>Units</td><td>Range</td><td>Format</td></tr>
<tr><td>x</td><td>x</td><td>x</td><td>Feet</td><td>+/- 99,999</td><td>PN</td></tr>
<tr><td colspan="3">Notes</td><td colspan="3">Notes</td></tr>
<tr><td colspan="3">- x</td><td colspan="3">- Density Altitude of the aircraft.</td></tr>
<tr><td colspan="3">UDS Conversion</td><td colspan="3">ESD Cnversion</td></tr>
<tr><td colspan="3">x
<i><u>To UDS:</u></i>
- x
<i><u>To LDS:</u></i>
- x</td><td colspan="3">$\text{ESD\_dec} = \left(\frac{19900}{65535} * \text{LDS\_int} - 900\right) * \frac{3.2808399\ \text{ft}}{1\ \text{m}}$
<i><u>To ESD:</u></i>
- Convert LDS to decimal.
- Account for units.
- Convert decimal to ASCII.
<i><u>To LDS:</u></i>
- Convert ESD ASCII to decimal.
- Account for units.
- Map decimal to uint16.</td></tr>
</table>

6.38.1 Density Altitude

Density altitude is the pressure altitude corrected for non-standard temperature variation. Density altitude is a relative metric of the takeoff, climb, and other performance related parameters of an aircraft.

6.39 Key 39: Outside Air Temperature Conversion

LDS	39		LDS Name	Outside Air Temperature	
UDS Mirror of LDS Item			Units	Range	Format
TBD			Celcius	-128..+127	int8
Notes					
- Temperature outside of aircraft. - -128..127 Degrees Celcius. - Resolution: 1 degree celcius.			LDS_dec = LDS_int		
UDS	x		ESD	At	
UDS Name	x		ESD Name	Air Temperature	
Units	Range	Format	Units	Range	Format
x	x	x	Celcius	+/- 99	PDD
Notes			Notes		
- x			- Outside air temperature measured at the aircraft		
UDS Conversion			ESD Cnversion		
x			ESD_dec = LDS_int		
To UDS: - x *To LDS:* - x			*To ESD:* - Convert int8 to string. *To LDS:* - Convert string to int8.		

6.39.1 Outside Air Temperature

The measured temperature outside of the platform is captured in the outside air temperature metadata item.

Annex A (Informative) – Examples of Predator UAV Local Data Sets:

EXAMPLE REQUIRES UPDATE FOR NEW CORNER POINT FORMAT (16 bits over 32)

```
// Sample Metadata for the Predator Local Data Set
// Corresponds to PLDS Dictionary as of June 28, 2005

static unsigned char test_klv[205]=
{
  0x06, 0x0E, 0x2B, 0x34, 0x02, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00,
                                              0x00, 0x00,// 16-byte Universal key for
                                              the PLDS
  0x81, 0xBB, // BER encoded length: 187 bytes below

//-key|length|Value-----------------
  0x02, 0x04, 0x09, 0x5F, 0x6A, 0x00, // 2.  UTC Time Stamp (Seconds), Seconds, 4
                                              bytes, uint32. 157248000 seconds
  0x03, 0x04, 0x01, 0x02, 0x03, 0x04, // 3.  UTC Time Stamp (uSeconds), Micro Seconds,
                                              4 bytes, uint32. 16909060 uSeconds
  0x04, 0x02, 0x80, 0x00,             // 4.  Platform Heading Angle, Degrees, 2 bytes,
                                              uint16. 180.0027466 degrees
  0x05, 0x02, 0xC0, 0x00,             // 5.  Platform Pitch Angle, Degrees, 2 bytes,
                                              int16. -10.000305 degrees
  0x06, 0x02, 0x19, 0x99,             // 6.  Platform Roll Angle, Degrees, 2 bytes,
                                              int16. 9.99939 degrees
  0x07, 0x01, 0x3C,                   // 7.  Platform True Airspeed, Knots, 1 byte,
                                              uint8. 120 knots
  0x08, 0x01, 0x37,                   // 8.  Platform Indicated Airspeed, Knots, 1
                                              byte, uint8. 110 knots
  0x09, 0x0A, 0x50, 0x52, 0x45, 0x44, 0x41, 0x54, 0x4F, 0x52, 0x20, 0x41, // 9.
                                              Device Designation, String, varies.
                                              "PREDATOR A"
  0x0A, 0x07, 0x45, 0x4F, 0x20, 0x4E, 0x4F, 0x53, 0x45, // 10. Image Source Device,
                                              String, varies. "EO NOSE"
  0x0B, 0x03, 0x55, 0x54, 0x4D,       // 11. Image Coordinate System, String, varies.
                                              "UTM"
  0x0C, 0x04, 0x2E, 0xF6, 0x12, 0x10, // 12. Device Latitude, Degrees, 4 bytes, int32.
                                              33.019603 degrees (ASI @ RB)
  0x0D, 0x04, 0xAc, 0x35, 0x60, 0xA0, // 13. Device Longitude, Degrees, 4 bytes,
                                              int32.  -117.095804 degrees
  0x0E, 0x02, 0x59, 0xD9,             // 14. Device Altitude, Feet, 2 bytes, uint16.
                                              20000 feet
  0x0F, 0x02, 0x55, 0x55,             // 15. Field of View (Horiz), Degrees, 2 bytes,
                                              uint16.  60 degrees
  0x10, 0x02, 0x19, 0x49,             // 16. Angle to North, Degrees, 2 bytes, uint16.
                                              35.55779 degrees
  0x11, 0x02, 0x12, 0x7D,             // 17. Sensor Roll Angle, Degrees, 2 bytes,
                                              int16. 12.9999694 Degrees
  0x12, 0x04, 0x07, 0x5B, 0xCD, 0x15, // 18. Slant Range, Feet, 4 bytes, uint32.
                                              123456789 feet
  0x13, 0x02, 0x04, 0xD2,             // 19. Target Width, Feet, 2 bytes, uint16. 1234
                                              feet
  0x14, 0x02, 0x3D, 0x27,             // 20. Obliquity Angle, Degrees, 2 bytes, int16.
                                              42.9991 degrees
  0x15, 0x04, 0x2E, 0xDF, 0x87, 0x43, // 21. Frame Center Latitude, Degrees, 4 bytes,
                                              int32. 32.957689 degrees
  0x16, 0x04, 0x3D, 0x15, 0xC0, 0xC7, // 22. Frame Center Longitude, Degrees, 4 bytes,
                                              int32. 85.90074304 degrees
  0x17, 0x02, 0x0E, 0xCE,             // 23. Frame Center Elevation, Feet, 2 bytes,
                                              uint16. 789 feet
```

```
  0x18, 0x04, 0x2E, 0xDF, 0x87, 0x43, // 24. Corner Latitude Point 1, Degrees, 4
                                               bytes, int32. 32.957689 degrees (ASI @
                                               Saber Springs)
  0x19, 0x04, 0xC2, 0xEA, 0x3F, 0x35, // 25. Corner Longitude Point 1, Degrees, 4
                                               bytes, int32. -85.900743374 degrees
  0x1A, 0x04, 0x2E, 0xDF, 0x87, 0x43, // 26. Corner Latitude Point 2, Degrees, 4
                                               bytes, int32. 32.957689 degrees (ASI @
                                               Saber Springs)
  0x1B, 0x04, 0x53, 0x44, 0xA3, 0xFD, // 27. Corner Longitude Point 2, Degrees, 4
                                               bytes, int32. 117.09580402 degrees
  0x1C, 0x04, 0x2E, 0xDF, 0x87, 0x43, // 28. Corner Latitude Point 3, Degrees, 4
                                               bytes, int32. 32.957689 degrees (ASI @
                                               Saber Springs)
  0x1D, 0x04, 0xAC, 0xBB, 0x9F, 0x60, // 29. Corner Longitude Point 3, Degrees, 4
                                               bytes, int32. -117.09580402 degrees
  0x1E, 0x04, 0x2E, 0xDF, 0x87, 0x43, // 30. Corner Latitude Point 4, Degrees, 4
                                               bytes, int32. 32.957689 degrees (ASI @
                                               Saber Springs)
  0x1F, 0x04, 0xA8, 0x35, 0x60, 0xA0, // 31. Corner Longitude Point 4, Degrees, 4
                                               bytes, int32. -123.456789 degrees
  0x20, 0x01, 0x01,                   // 32. Icing Detected, Code, 1 byte, uint8. code
                                               1: no icing detected
  0x21, 0x02, 0x40, 0x00,             // 33. Wind Direction, Degrees, 2 bytes, int16.
                                               90.00137 degrees.
  0x22, 0x01, 0x0F,                   // 34. Wind Speed, Knots, 1 byte, uint8.  15
                                               Knots
  0x23, 0x02, 0x19, 0x9A,             // 35. Static Pressure, PSI, 2 bytes, uint16.
                                               10.00076 PSI
  0x24, 0x02, 0x59, 0xED,             // 36. Density Altitude, Feet, 2 bytes, uint16.
                                               20020 Feet
  0x25, 0x01, 0xA3,                   // 37. Outside Air Temperature, Celcius, 1 byte,
                                               int8. -35 degrees
  0x01, 0x02, 0x09, 0xB2              // 1.  Checksum, binary, 2 bytes, uint16.
                                               0x163F = 5695
};// end of test_klv
```